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Practical entomology : insects injurious to farm and garden crops, the character of the injury, the insect causing it, the remedy, briefly and plainly stated

A. D. Hopkins

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Practical Entomology.

INSECTS INJURIOUS TO FARM AND GARDEN CROPS.

THE CHARACTER OF THE INJURY. THE INSECT CAUSING IT.

THE REMEDY.

BRIEFLY AND PLAINLY STATED.

A. D. Hopkins and W. E. Rumsey.

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Introduction.

This bulletin is prepared especially for the busy practical farmer and gardener who desire a work of reference containing readily accessible, and plainly stated information upon some of the more important facts with reference to insect injuries to cultivated plants. It is also intended to be of service to the young student of economic entomology who desires a simple guide to the study of the common insects and the character of their work.

Difficulty in Determining the Prime Cause of Injuries and Proper Remedies.

The grower of farm and garden crops as well as the young entomological student is often at a loss to determine whether or not a given trouble is the work of insects. Even when it is known that a trouble is caused by insects, it is often difficult, if not impossible for one who is not experienced in entomological questions, to decide, with any degree of accuracy, what particular kind of an insect is the prime cause of it. Especially is this difficult and confusing, when, as is sometimes the case, a large number of different kinds of insects are associated with the injury, or occur on the injured plants. Thus, it often occurs that the wrong insect is blamed for the trouble, and a remedy is applied that does more harm than good.

The character of a trouble affecting a plant, a growing crop or a stored product, is the first thing to attract the attention of the grower, but in order for him to determine, from the usual form of published descriptions, what remedy to apply, he must first find the insect that caused it, and then determine the name of the pest, and by means of this, search for the desired published information. Ordinarily, this is a tedious process for any one but an entomologist, the greatest difficulty being to find by description, the name of the insect, especially if the descriptions include scientific names and technical terms.

Insects Known by Their Work.

As a rule, every kind of an insect enemy of plants has some peculiar habit of attack and manner of feeding, that causes the infested plant to show some peculiar condition or symptom, by

which the insect causing it may be determined. In fact, it will often indicate what remedy to apply even if the insect is not observed.

The Cause of a Trouble and the Remedy Determined by the Symptoms.

It is the object of the plan followed in this Bulletin to simplify the matter by making the characters of a trouble the prime features to guide the reader to an account of the cause and the remedy, just as the name of a disease and the remedy is determined by the character of the symptoms.

Instructions.

If a trouble appears, affecting cultivated plants, note the general appearance of the plant, the character of the injury, and the kinds of insects associated with it. Then refer to the general characters given in this Bulletin under the name of the plant, and to the special characters under the name of the part of the plant that is injured. Then by means of the numbers, refer to and examine the brief descriptions of the insects, and if all of the descriptions agree with the characters of the trouble, and of the insects found with it, examine the preventives, remedies, etc., referred to by the numbers.

The Numbers.

The references are made back and forth by means of numbers to avoid the frequent repetition that would otherwise be necessary. The reader in tracing up these numbered references will find it convenient, and avoid possible mistakes—when there are several references to one line of subjects—by copying the numbers on a slip of paper.

The Scientific Names of Insects.

The scientific names of the insects mentioned are included in foot notes for the benefit of those of our readers who may desire to know them and to indicate to the entomological reader what particular insect is referred to by the common name.

Compiled Matter in Small Type.

The portion of this bulletin that appears in small type is compiled from the writings of the best entomological authorities, and refers to subjects that have not come under our observation. This information was selected and compiled mainly by the junior author.

Original Matter In Ordinary Type.

The portion that appears in ordinary type was prepared by the senior author mainly from personal studies and verification of the subject treated.

The Plan.

The plan followed in this Bulletin was suggested by that of a recent publication on corn insects, by Professor S. A. Forbes, State Entomologist of Illinois*. A somewhat different arrangement is here adopted, however, and some original features introduced, with a hope that something will be added to the usefulness of this class of entomological publications.

There is yet room for considerable improvement along this line, and the observing farmer and gardener in his correspondence with the Entomologist can, from a practical standpoint, doubtless, make some valuable suggestions and contribute important information that will materially aid in improvement of future bulletins on "Practical Entomology," which we hope to issue, from time to time.

General Information upon Insects.

The Adult Forms of Insects.

The adults or perfect forms of insects have six legs and usually have wings. *Bees* and the insects belonging to this class have four wings, except a few kinds that are wingless. *Flies* have two wings, with a few forms that are destitute of these organs. *Butterflies and Moths* have four broad wings, with the exception that females of some species are wingless. *Beetles* have two hard-shelled wing covers and two thin, folding wings. *Bugs* have four wings, except a few that are wingless, and in one group of this class of insects the wing covers are thickened at the base, overlapping each other when folded, and thin at the outer ends, while in another group the wing covers are of the same thickness throughout and when not in use, usually slope at the sides of the body, roof-like. The under wings in both cases are thin and transparent.

Plant Lice or Aphids: adults of the same species may be winged or wingless—the winged forms having two pairs of thin ones. *Grasshoppers* have two wing covers and two thin, folding, under wings.

The Young Forms of Insects.

The young or growing forms of insects are known by the technical name of *larva*, plural *larvæ*. The common names for the

*A Monograph of Insects Injurious to Indian Corn, Part I. In 18th Report of the State Entomologist of Illinois, 1891-2.

young of bees are maggots, slugs and worms; the young of *Flies*, are maggots; the young of *Beetles*, grubs or worms; and of *Butterflies*, caterpillars or worms. The young of *Grasshoppers*, bugs and plant lice, are called nymphs and resemble the adult, except that they are wingless and of various sizes.

The Intermediate Forms.

Most young forms of insects when full grown cease feeding and change to an inactive form called the *pupa*—plural *pupæ*, which is usually enclosed in a silken or earthen case called its pupa case or cocoon. This inactive form of *Bees*, *Beetles and Flies* has no common name, hence is referred to by the technical term. This stage of *Butterflies* and moths is called the *chrysalis*. The intermediate form of the true *Bugs*, *Grasshoppers* and *Plant Lice* differs but slightly from the young stages, and like them are active and feed, differing in this respect from the pupæ of bees, flies, beetles and butterflies.

Methods of Feeding.

The adults of butterflies and moths suck their food, but are not injurious. Their young bite and consume their food and are among the most injurious insects. Both the adults and young of beetles bite their food, some of them feeding upon plants and others on insects. The adults of flies have mouth parts formed for piercing and sucking; the mouth parts of some of their young are formed for biting, while that of others are formed for sucking. Some flies are enemies of plants, while others are parasitic and feed upon insects. Some of the adults of bees have mouth parts formed for sucking, while others bite the substance upon which they feed. Some of the young of bees have biting, while others have sucking mouth parts and feed upon both plants and insects. The bugs and plant lice in all of their stages have mouth parts formed for sucking, while all stages of the grasshoppers and locusts have mouth parts formed for biting.

Insects that Can Be Poisoned.

Nearly all insects that have mouth parts formed for biting may be poisoned, if it is possible to apply the poison to the substance upon which they feed.

Insects that Can Not Be Poisoned.

Insects that suck their food from beneath the surface of their food plant, cannot be killed by poisons, but can be killed with liquids, powders and gases, that cause death by coming in contact with the surface of their bodies or breathing pores.

INSECT INJURIES TO FARM AND GARDEN CROPS.

BY A. D. HOPKINS AND W. E. RUMSEY.

THE GRASSES,

INCLUDING ALL OF THE CULTIVATED KINDS.

THE ROOTS.

The plants are stunted and fail to make normal growth in good soil; they wilt or die in patches, or the sod is easily separated from the surface soil.

If the plants wither or die, and the roots are cut off so the sod can be rolled up like carpet, and white grubs are common, see No. 1.

If the plants are dwarfed and grub worms are not present, see Nos. 2, 3, 6.

If whitish blue plant lice are common on the roots, see No. 6.

If slender, shining, wire-like worms are present, see No. 2.

If large, dirty-brown maggots are common in the soil, see No 3.

If the stalks and roots are cut off at or above the crown of the roots, see Nos. 1, 4, 5.

Injury by the Young of Beetles.

The sod dies in patches, or the grass has a dwarfed, unthrifty appearance.

1. *The White Grubs*[1].—Soft-bodied, whitish grubs with brownish or reddish heads, and with six small legs near the head; hinder portion of the body thick and smooth; when disturbed they curl up so the head touches the tail end, common in sod lands.

There are many kinds of white grubs, all closely resembling each other, some of which simply feed on manure and decaying vegetable substance, while others feed on the roots of plants. Those feeding upon roots vary in size when matured, from one-half to two inches long, and may usually be distinguished from those that feed in manure by their reddish heads, especially the larger and more destructive kinds.

1. Numerous species belonging to the following genera: Lachnosterna, Cyclocephala, Allorhina, Prionus and Macrodactylus.

All these different kinds of grubs change to beetles like the June bug, May beetle, dung beetle and rose bug.

The female beetles of the injurious kinds lay their eggs usually in grass land, from May to July. The young grubs feed upon the roots, and remain in this immature stage from one to three years, varying with the different species. They then cease feeding and change to an inactive form called the pupa.

White grub worms are common in West Virginia and may be classed among our worst insect pests, attacking corn, grass, wheat, and other small grain, potatoes and other vegetables.

For remedies, etc., see Nos. 175, 178, 181, 228, 233, 239 and 253.

2. *Wire Worms*[1].—Slender, brownish, shining, hard-bodied worms, one-half to one-fourth inches long, resembling somewhat a piece of rusty wire; consume or bore into the roots and base of the plant; the young of click beetles or "snapping bugs."

The eggs are laid by the adult beetles in grass land. They remain in the worm stage about two or three years, changing to dormant forms about July of the second or third year, remaining in this stage about three weeks, when they change to beetles which remain in the soil until the following spring, when they emerge to deposit eggs for another brood.

Wire worms of many kinds are common in West Virginia, and are serious pests, attacking the same kind of plants as does the white grub.

For remedies, etc., see Nos. 175, 178, 180, 181, 193, 195, 227.

Injury by the Young of Flies.

3. *The Meadow Maggots*,[2]—Large, dirty brown, footless worms, or maggots, from one-half to one inch long, common under dead grass and in damp places during early spring; also common in sod where they are supposed to do considerable damage by feeding upon the roots. They change to large, mosquito-like flies with very long legs and occur in great numbers flying over meadows and other grass land in the spring and fall.

The eggs are deposited by the flies in grass land during the spring. These hatch in a short time into small blackish maggots that feed upon the roots, grass and other plants until they are full grown when they change to a chrysalis forms from which a fall brood of flies emerge; another set of eggs are deposited, and the young hatching therefrom remain in the ground over winter.*

These insects, of which there is a large number of species, are extremely common in portions of West Virginia, often occurring in the early spring and fall in immense swarms, especially in flat, undrained meadow and pasture lands.

For preventives, remedies, etc., see Nos. 195, 234.

1. Numerous species belonging to the following genera: Cardiophorus, Drasterius, Agriotes, Melanotus and Asaphes.

2. Numerous species Tipulidae. *Compiled.

Injury by the Young of Moths.

Stalks and roots severed at or below the crown of the roots.

4. *Cutworms*—(See No. 7). Young cutworms evidently do considerable damage to grass roots.

5. *Web Worms.*—(See No. 8) are also classed among the enemies of the grass roots.

The damage to meadows and pasture by cutworms and web worms feeding upon the roots of grass is doubtless considerably greater than is generally supposed.

Injury by Plant Lice.

6 *The Grass Root Louse,*[1]—A whitish or yellowish plant louse, without honey tubes on the hinder part of its body, but with a pair of minute, circular openings instead, thus differing in appearance from the Corn Root Louse. It attacks the roots in the same manner, however, and is attended by ants. The life history is not known, but it is probably similar to that of the Corn Root Louse. See No. 71.

This insect, or one similar to it, has been observed in Wood county, where it was quite injurious to grass in the meadows.

For preventives, remedies, etc., See No. 178, 196.

THE STALKS.

Stalks severed near the ground; central shoot dies and turns yellow; leaves of stalk wholly or partly consumed, or the plants have a sickly appearance. If stalks are cut off near the ground, see Nos. 7, 8. If the central shoot or the upper joint and head dies, see Nos. 9, 10, 11.

If the stalk and leaves are wholly or partly consumed, see Nos. 14, 15, 16, 17.

If the plants have a sickly appearance and are covered with lice or small stinking bugs, see Nos. 12, 13.

Injury by the Young of Moths.

Stalks cut of and left on the ground or the central shoot dies.

7. *Cut Worms.*[2]—Soft-bodied, greasy looking worms, varying in length when full grown, from one to nearly two inches, of a dingy brown gray, or greenish color, with indistinct longitudinal markings, and provided with sixteen legs. When removed from the soil they curl themselves up in the same manner as does the

1. Schizoneura panicola. Thos.

2. Numerous species belonging to the following genera: Agrotis, Mamestra, Hadena, Laphygma, Prodenia and Nephelodes.

white grub. They eat into or cut off the base of the plant beneath or above the surface, or consume the entire plant.

They feed principally at night and during warm, cloudy days, and changing to a brown, smooth and shining chrysalis from which dull, grayish moths emerge in the spring and summer.

There are a great many kinds of cut worms that attack grass, corn, &c., all having somewhat similar habits, and although the life history of each species differs somewhat, it may be generally stated as follows:

The eggs are laid by the female moths—usually on grass; when the eggs hatch the young worms enter the ground and feed upon the tender shoots and roots of grass and other plants. Upon the approach of Winter they bury themselves in the soil and remain there until Spring, when they become active and attack almost any green vegetation they find, often traveling a considerable distance to find it, or climb the stalks of plants to feed upon the leaves. They become full grown by the first hot days in May and June, when they cease feeding and burrow for some distance into the soil where they form a cell in which they change to brown, smooth and shining chrysalies, from which, in three or four weeks, the adult moth emerges to deposit eggs for another brood.

Cut worms are among our very worst insect enemies of farm and garden plants in West Virginia, and during the spring and summer of 1895, they were especially destructive in the Ohio Valley, where it was necessary to replant corn, potatoes and other crops a number of times before a stand could be secured. The loss to farmers occasioned by the depredations was enormous.

For preventives, remedies, etc', see Nos. 173, 181, 197b, 199, 228, 225, 234, 241, 239, 252.

8. *The Web-Worms*[1], Whitish, pinkish or brownish worms, one-half to one inch long, covered with tufts of bristly hairs; living in a tube constructed of webs attached to the side of the stalk; feeding during the night upon the base of the stalk beneath the surface of the ground.

These pests are the young of white or yellowish moths, with narrow, satin-like wings; common flying in meadows and pasture fields in late summer and fall; their wings fold close to the body when at rest.

The eggs are deposited by the moths near the roots of grass from July to October; hatching in about a month, the young feed as do cutworms, on the tender shoots and roots of grass, and remain in the ground over winter to attack grass and corn in the spring, and reach their full growth in May and June, then changing to chrysalis from which moths emerge to deposit more eggs.*

There are a great many kinds of this class of insects known to infest grass, some of them also attacking corn and other plants. Within the last year or two they have become extremely destructive to corn in portions of West Virginia, especially in the counties bordering on the Ohio river. They were also common corn pests in Monongalia county during the spring of 1895.

For preventives, remedies, etc., see Nos. 181, 197h, 199, 225, 230, 248.

1. Numerous species belonging to the genus Crambus. *Compiled.

9. *The Stalk Borer.*—See No. 73. Very young examples, evidently of this insect, have been observed in blue grass stalks feeding on the base of the upper joint, causing "White Top."

Injury by Two-Winged Gnats

The central shoot or head dies and turns light yellow.

10. *Stem Maggots*, (see No. 40.)

11. *Injury by Thrips*,—(see No. 43,) causing the same conditions as the Stem Maggots and Stalk Borers.

Injury by True Bug and Plant Lice.

Plants dwarfed and sickly and covered with small, reddish or black bugs.

12. *The Chinch Bug*—(See No. 45.) Often a serious pest.

13. *Plant Lice.*—(See No. 56.) Are sometimes quite injurious, but the injury is seldom noticed.

THE LEAVES.

Leaves partly or wholly consumed, presenting a ragged appearance, or shriveled and whitish. If grasshoppers are common see No. 16, 17. If grasshoppers are not common, and smooth, yellow striped caterpillars are found in large numbers, see No. 14.

If the injury is done at night, see No. 16. If leaves are shriveled and whitish and covered with small stink bugs or green lice, see Nos. 18, 19.

Injury by the Young of Moths.

Leaves partly or wholly consumed.

14. *The Army Worm*,[1]—A dingy, black-colored worm, one and three-fourths inches long, with black and yellow stripes on its back, and with the lower part of the body greenish; when abundant, consuming the leaves on all of the plants in its line of march. The worm changes to a brown moth, measuring about one and three-fourths inches from tip to tip of wings, when expanded.

The eggs are deposited by the moth on grass or growing grain in the spring; and hatch into greenish worms which subsequently take on a darker hue. The worms continue to feed for two to four weeks and when the plants upon which they feed are destroyed in one section, they move in a body in search of food, destroying all growing grass or grain that comes in their way. When they have attained their full growth they burrow into the ground and change to chrysalids and remain there until spring, when the moth emerges. Some of the moths may emerge in the fall and pass the winter in that form.

This insect doubtless occurs in West Virginia, but we have no

1. Leucania unipuncta.

information of its having done serious damage to grass or other crops. It is liable to appear, however, whenever the conditions are favorable for it.

Preventatives—remedies see Nos. 171, 181, 182, 200, 201, 222, 225.

Climbing Cutworms. (See No. 7.) Cut worms with climbing habits may do considerable damage.

Many other caterpillars, the young of various kinds of moths, feed upon the leaves of grass, but are not especially destructive.

Injury by Locusts and Grasshoppers.

Leaves and portions of the stalk wholly or partially consumed, presenting a ragged appearance.

Short Horned Grashopper.

16. *The Eastern Red Legged Locust*[1]—The adult a brownish, medium sized hopper about one inch long with short antennæ, or horns, with pale under wings and with the second joint, from the body, of the hind legs a bright red. The young vary in size from minute, flea like hoppers to the size of the adult and vary in color from gray to yellow. The young forms are distinguished from the adults by the absence of fully developed wings.

The eggs are deposited in the pod-like masses just beneath the surface of the ground, in the latter part of the summer or early autumn. The eggs remain in the ground over winter and hatch in April and May.

This species is a near relative of the Rocky Mountain Locust which has from time to time caused great destruction of crops in the Mississippi Valley.

This eastern species often occurs in immense numbers in restricted localities in West Virginia, and has at times caused considerable alarm. It was especially abundant in Mineral county in 1891; also in a field near Morgantown in 1895, and has been reported from time to time from other sections.

For preventives, remedies, etc., see Nos. 223, 225, 235, 241, 252a.

The Long-Horned or True Grasshoppers.

17. *The Meadow Grasshoppers*[2].—Medium sized green or greenish, long winged, long horned, and long legged grasshoppers, with somewhat similar life history and habits to that of the Locust.

There are a great many species, but none of them occur in sufficient numbers to alone cause much trouble, but co-operating with each other and with the locusts they often do serious damage. Remedies same as for locusts.

1. Melanoplus femur-rubrum.

2. Locustidæ.

Injury by Bugs and Plant Lice.

Leaves shriveled and sickly, covered with lice and bugs.

18. *The Chinch Bug*, (see No. 45.)

19. *Plant Lice*, (see No. 56.)

THE HEADS.

Heads are eaten or cut of.

20. *The Army Worm*, see No. 14; also Grasshoppers, 16, 17 and Climbing Cutworms (?) No. 15, 20a.

20*a*. *Climbing Cutworms.* See No. 7.

About the year 1876, in June, a dark colored worm made its appearance in Jackson county, cutting off and eating the young heads of timothy at night. Probably it was one of the climbing cut worms.

THE SEED.

INJURY BY THE YOUNG OF BEETLES.

21. *The Meal Worm.*[1]—A slender, hard-shelled, smooth and shining, redish-brown worm, about one inch long, common in hay seed on barn floors, evidently feeding upon the seed. This worm changes to a black beetle about five-eighths of an inch long.

This insect often occurs in great numbers under loose boards, boxes or barn floors. The damage by it is not great, however, except where the seed is desired for sowing

For preventives, remedies, etc., see No. 191.

CLOVER.

THE ROOTS.

The plants wilt and die, or dwarfed and fail to make normal growth in good soil.

1. Tenebrio molitor.

If the plants wilt and are easily pulled up, separating just below the crown, and the main root is hollowed out or filled with borings, see No. 22.

If the plants are stunted and the roots are not hollowed out, see No. 23*a*.

If eaten off, see No. 23.

Injury by Beetles or Their Young.

BORING IN THE ROOTS.

22. *The Clover Root Borer*[1]—A small brownish or black cylindrical beetle, one-tenth of an inch long, boring in the main root and crown of red clover. The young, a small white grub, one-eighth of an inch long, feeding on the inner portion of the root.*

In the spring the beetles bore into and deposit their eggs in the crown of the roots and in a few days the larvæ hatch and burrow downward, feeding in the main root and mining into the larger branching ones. During the latter part of the summer they reach full growth and changing to the pupæ within the roots, shortly after emerge as adults. There is probably more than one brood of this insect in a year. They pass the winter in the roots, in their different stages, and the adults appear in the spring.†

This is an extremely destructive insect in some sections of the country, and doubtless occurs in West Virginia, but has not been observed by us or reported by correspondents. Clover growers in the State should look out for it and if found, report the fact to the Station.

No successful remedy known.

23. *The White Grub*, (see No. 1, 23*a*.) and *Wire Worms* (see No. 2,) may do some damage to the clover roots and thus prevent the perfect development of the plant.

THE STALK.

The stalks are mined, cut off near the ground, or the tender portions consumed.

If the stalks are injured by an insect mining through the pith, see No. 24.

If cut off, see No. 25.

If consumed, see No. 25.

Injury by the Young of a Beetle.

Slender Worms Mining in the Stalk.

24. *The Clover Stem Borer*[2].—A cylindrical, slender, whitish or yellowish worm, about one-half of an inch long, mining in the pith of the stalk or stem of red clover; changing to a small, slender beetle, about one-fourth of

1. Hylastes obscurus, Marsham.
2. Languria mozardi, Fab. *Compiled. †Compiled.

an inch long, with its head and front portions of its body yellowish-red and the under portions shining, bluish black

This beetle deposits her eggs on or in the outer portion of the stem of clover, rag weed, and many other plants; the larvæ feeding on the pith, and as a rule, remaining in the base of the stem until spring, when it changes to the pupa and adult.

This is a common insect in West Virginia, but is not known to be especially injurious to clover, the common rag weed appearing to be its favorite food plant; the larvæ occurring quite common in the dry weed stalks during the winter and early spring.

For preventives, remedies, etc., see 171, 174.

25. *Cutworms*, No. 7, Army worm, No. 14 and Grasshoppers No. 18, are all injurious to the stalk and may at times prove very destructive.

THE LEAVES.

Leaves consumed, full of holes or have a ragged appearance.

If the leaves are full of holes and have the edges eaten out, or the plants are entirely defoliated and no insects are visible through the day, see No. 26.

If the leaves have a ragged appearance and grasshoppers are abundant, see No. 27.

If the leaves are only moderately injured, see No. 29, 30, 32.

If the leaves and a large part of the plant is consumed and smooth, striped worms are common, see No. 28.

If leaves are folded or webbed together, see No. 31, 33.

Injury by the Adult and Young of a Beetle.

Leaves full of holes and edges of leaves eaten out by beetles and greenish worms.

26. *The Clover Leaf Beetle*[1].—A dark brown, snout beetle, about three-eighths of an inch long, feeding on the leaves at night, eating holes in them and hiding under leaves, rubbish, etc., during the day; the young or larvæ is a greenish, legless grub, about one-half an inch long, feeding on the edge of the leaves; eating out circles as if cut out with a punch. Like the beetle the young feed at night and hide during the day.

The eggs are deposited by the female at the rate of 200 to 300 on the plants in the spring and latter part of summer. The spring brood appears in May and the larvae reach their full growth in seven or eight weeks, when they make their cocoons, usually in the soil, just beneath the surface and the beetles emerge about a month later.

The eggs deposited by this summer brood of beetles soon hatch, and the worms continue to feed until cold weather, some of them possibly changing to pupae and adults, while others remain in the larvae stage until spring, when they attack the young clover.

This is a foreign pest and a new one in West Virginia, first at-

1. Phytonomus punctatus, Fabr.

tracting attention on account of the destruction wrought by it in Berkeley and Hampshire counties in May, 1894.

It makes its appearance in the spring in enormous numbers, and were it not for a disease that is very destructive to it, it would hardly be worth while to try to grow clover in localities where it has once been established.

See diseases, No. 250.

27. *Grasshoppers and Locusts*, (see Nos 16, 17.) are often quite destructive to young clover in the spring, causing the leaves to have a ragged appearance when they are not entirely consumed.

Injury by the Young of Moths and Butterflies.

28. The Army Worm, see No. 14.

29. Climbing Cutworms, see No. 7.

30. *The Clover Leaf Folder*[1].—A small, greenish caterpillar, folding and webbing the leaves together.

31. *The Clover Looping Caterpillar*[2].—A kind of looping or measuring worm, changing to a gray moth that is very common in meadows, flying up as we walk along through the grass. Common in West Virginia.

32. *Caterpillars of Butterflies.*—Small, greenish or yellowish caterpillars, the young of the common *Lemon yellow*[4] and *Orange yellow butterflies*[5], the small *Tailed blue butterfly*[6] and the brown *Silver spotted skipper* butterfly and other similar larvæ feed upon the clover leaves and doubtless do considerable damage. All are more or less common in West Virginia.

Injury by the Young of a Gnat.

33. *The Clover Leaf Midge*[8].—A minute maggot living in the leaves, with habits similar to No. 34. Has not been observed by us in West Virginia.

THE HEADS AND SEED.

Heads dwarfed, and greenish when they should be in bloom, and seeds fail to develop.

1. Hypena scabra.
2. Drasteria sp.
4. Eurymus philodice.
5. Eurymus eurythema.
6. Thecla Calanus.
7. Epargyreus tityrus.
8. Cecidomyia trifolii.

Injury by the Young of a Gnat.

34. *The Clover Seed Midge*[1].—A minute, orange-colored maggot, about one-tenth of an inch long, feeding on parts of the flowers and on the tender growing seed; changing to a minute two-winged gnat.

The eggs are deposited by the gnat in the heads; these hatching, the young feed at first upon the tender, inner portions of the flower, and later upon the seeds, from which they suck the liquids and thus prevent their development. When the maggots are full grown they leave the heads and fall to the ground where they change to pupæ and the gnats soon appear to deposit more eggs. There are two or three generations each year.

This is an extremely destructive insect in certain sections of the country, making clover seed growing for market impossible. It has not been observed or reported to us in West Virginia, but doubtless occurs in the State.

For remedies, preventives, etc., see No. 187, 189.

THE HAY.

Hay in stacks and mows containing white, silky webs and excrements resembling coarse gunpowder.

Injury by the Young of a Moth,

Feeding upon the leaves of the hay in the stack or mow.

35. *The Clover Hay Worm*[2].—A brown worm or caterpillar about one-half of an inch long, living in clover hay, which it webs together and feeds upon the leaves; changing to a pretty purple and golden marked moth, expanding about four-fifths of an inch.

The eggs are deposited by the moth upon the hay, the larvæ hatching therefrom feed upon it and become full grown in a few weeks, then make silk cocoons in which they change to the chrysalis stage and soon appear as moths.

This insect is, as a rule, more liable to attack hay that has been allowed to stand over one or more years in stacks or mows; usually more abundant in the hay near, or at the bottom. This is a common pest in West Virginia.

For preventives, remedies, etc., see 190, 191, 192.

WHEAT, BARLEY, OATS AND RYE.

THE SEED IN THE GROUND.

If the seed in the ground fails to germinate, it may have been

1. Cecidomyia leguminicola, Lint.
2. Pyralis costalis, Fab.

destroyed by Ants No. 62; Wire Worms, No. 2; Grub Worms, No. 1; or Fungous Gnats, No. 88.

THE ROOTS.

If the plants turn yellow or wither and die, the cause may be due to the work of Wire Worms, No. 2; Grub Worms, No. 1; Corn-root Worms, Nos. 69, 70; Root Lice, No. 71; Cut Worms, No. 7; or Meadow Maggots, No. 3.

THE STALK.

If swellings and blister-like places occur on or near the joints, and some of the joints thus affected are bent over, see Nos. 36, 37.

If the stalk breaks off near the ground and upon examination a large burrow has been made through the joints, see No. 38. If the base of the stalk is shriveled and objects like flax seeds are found under the sheath of the leaf, see No. 39.

If the top or upper joint and head dies and turns white, is cut off, or spiral mines occur in the straw beneath the sheath, see Nos. 40, 41, 42, 43, 44.

If entire stalk dies and mines at the base extend into the roots, see No. 49.

If the top dies and holes are bored in the side of the stalk, see No. 44.

If the base of the upper joint shrivels and minute, slender, black insects occur under the sheath, see No. 43.

If the plants have a sickly appearance, turning whitish in patches over the field, and the stalks are covered with minute red, and larger black stinking bugs, see No. 45. If covered with greenish plant lice, see No. 46.

If young plant takes on a darker green hue in patches over the field, fail to head out and finally turn yellow or brown and flax seed objects occur under the sheaths, see No 39.

If the leaves or stalks are eaten, see Nos. 47, 48.

Injury by the Young of Four-Winged Gnats.

Small maggots causing galls or swellings on the joints Nos. 36-37 or slender worms mining in the stalks causing the upper portion of entire stalk to die. No. 38.

36. *The Joint Worm*[1].—A yellowish-white maggot one-fifth of an inch long, living in swellings on the joints and sheaths, changing to a minute four-winged gnat.*

The eggs are laid by the gnat in the stem near the joints, and they develop in the swellings or galls that form over them. The maggots are supposed to pass the winter in the galls or in the stub-

1. Isosoma hordei, Harris. *Compiled.

ble, in the field and in the straw stack; the adults emerging in the spring.*

This insect occurs in West Virginia, but no special complaint has been made of injury by it. It has from time to time proven a serious pest in other sections of the country.

For preventatives see Nos. 173, 178, 190, 219, 232.

37. *The Straw Worm*[1]—A pale, yellowish maggot, closely resembling the Joint Worm, attacking the stalk in a similar manner, and changing to a four-winged gnat.

The eggs are laid on the stems or the forming heads of the young wheat, in the spring by wingless females, these hatching, produce a brood of winged female gnats in June, which lay their eggs in or near the second joint from the head; the maggots from these eggs change to pupæ in the fall and remain in the stubble and straw until spring, when the gnats emerge.*

This insect is a serious pest in some sections of the country, and doubtless occurs in West Virginia.

For preventives, remedies, etc., see Nos. 173, 178, 219, 232.

38. *The Wheat Saw Fly.*[2] A yellowish, milky-white worm, about one-half an inch long, mining in the straw between and through the joints; changing to a shining black four-winged fly, banded and spotted with yellow.*

The eggs are deposited in the stalk just before the wheat begins to head. The young worm enters the stalk and works its way down and through the straw, reaching the base below the first joint by the middle of July. It then cuts a circle from within, and just below this point it makes its cocoon where it remains till spring. It then changes to a pupæ and the adult emerges in May. The straws often break off when the cut is made, and wheat thus affected "lodges" badly.*

This is a comparatively new wheat pest in this country, and probably occurs in West Virginia. A trouble resembling that caused by this insect was reported from Wirt county in 1890.

For preventives, remedies, &c., see Nos. 173, 181.

Injury by the Young of Two-Winged Gnats

Small maggots, causing young plants to be dwarfed and to change from dark green to yellow or brown, fail to head out or stalks shriveled at base and bend over or break off. See No. 39.

Slender maggots, mining in straw, causing the heads and upper joint to die and turn whitish. No. 40, 43.

39 *The Hessian Fly Maggot*[3]. A small footless maggot, about 3-20 of an inch long when full grown; attacking the young and growing wheat under the sheath of the leaves near the lower joints of the stalk in the spring,

1. Isosoma tritici, Riley.
2. Cephus pygmoeus, Linn.
3. Cecidomyia destructor. Say. *Compiled.

and at the base of the young plants in the fall; causing an imperfect development of the straw and grain, or preventing the plant from developing a head; plants thus affected will be found upon examination to have either maggots or objects like flax seed beneath the sheath from which a small, dusky, two winged gnat emerges.

The eggs are deposited by the fly or gnat on the upper surface of the leaves near the stalk in May or June. The young maggots make their way down the outside of the straw beneath the leaf sheath to one of the lower joints, usually the lowest one, where they station themselves and become imbeded in the soft part of the stem. Here they remain until fully matured, when they change to the flax seed stage,—the pupae,—and the flies soon emerging from these, deposit their eggs on volunteer wheat, oats, rye, etc., also in fall sown wheat and rye in September and October; the earlier sown wheat usually being affected the worst. They pass the winter in the flax seed stage in the old straw and in volunteer and sown wheat, and the fly emerges in the spring.

This is a common wheat pest in West Virginia, often causing serious loss.

For preventives, remedies, etc., see Nos. 173, 178, 185, 189, 219, 232.

40. *The Wheat Stem Maggot.*[1]—A whittish or greenish worm or maggot, one-fourth of an inch long, mining in the stalks and causing the top to die; changing to a small two-winged fly.

The eggs are deposited, in May and June, upon the stalk near the upper joint in which the worm burrows and develops causing the upper joint and head to die. The flies emerging from this brood in July, deposit eggs on the volunteer wheat and grass and one or two broods of flies develop, the last brood in time to deposit eggs on the young wheat in September and October is when the maggots kill the central shoot and pass the winter in the stalk of the young plants, to appear as flies in the spring.

This was a common wheat pest in Monongalia and Preston counties, in 1895, and doubtless occurs in other sections of the State.

For remedies, preventives, etc., see No. 178, 187, 188, 219, 232.

41. *The American Frit Fly Maggot.*[2]—Resembles and has similar habits to the preceding species.

For remedies, preventives, see No. 178, 187, 188, 219.

42. *The Companion Fly Maggot*[3].—Similar to the two preceding species in form and habits, but much smaller.

All of the above, therefore, having similar habits, should have similar treatment. See No. 39.

Injury by Thrips.

Minute, slender insects, causing the same conditions as the three species mentioned above.

43. *Thrips*[4].—Exceedingly small, slender, jet black, red or yellowish, active insects, occurring under the sheath just above

1. Meromyza americana. Fitch.
2. Oscinis variabilis? Lœw.
3. Oscinis sp(?)
4. Limothrips poaphagus(?)

the base of the upper joint, where they suck the substance from the stalk and cause it to wither and die; there is little difference in the young and adults; common everywhere, but the damage by them is not, as a rule, serious.

Injury by the Young of a Moth.

A small worm boring in the stalk, causing the top to die.

44. *The Stalk Borer.*—(See No. 73) attacks wheat and other small grain, causing the same white top appearance as mentioned above.

Injury by Chinch Bugs and Plant Lice

□Small, dark or reddish striped bugs, or green plant lice covering the stalk and leaves and sucking the sap.

45. *The Chinch Bug*[1].—Adult a black bug, marked with white, one eighth of an inch long; young forms reddish, resembling lice. All stages suck the sap from the stalk and leaves and prevent the plant from developing.

The eggs are deposited by the adults, in the spring on, the roots of the young plants; they hatch in about two weeks into little red, louse-like bugs which feed at first on the roots and afterwards on the stem, leaves and head. They reach maturity in six or seven weeks and migrate to other plants, often in enormous numbers, going from wheat to oats, corn and other plants.

This insect is an extremely destructive one, but fortunately has not proven to be very common in West Virginia, except in restricted localities. During the summer of 1895 it did considerable damage in Grant and Hampshire counties, and I have been told that it occurred several years ago in Mason county.

For preventives, remedies, etc., see Nos. 171, 172, 173, 209, 222, 251.

46. *The Grain Louse*,—(See No. 56,) also attacks the stalks of wheat and other grain; a common pest.

Injury by the Young of a Moth and by Grasshoppers.

47. *The Army Worm.*—See No. 14.

48. *Grasshoppers and Locusts.*—See Nos. 16, 17.

Injury by the Young of a Beetle,

A small grub living in the base of the stalk, causing the stalk to die and change to a whitish color which shows distinctly among the green plants.

1. Blissus leucopterus; Say.

49. *The Wheat Stem Grub*[1]—A small, wrinkly, whitish grub, about one-half inch long when full grown; boring in the top root and first joint above the root; the burrow packed with borings, killing the stalk after it has formed a head; changing to a black snout beetle related to the plum curculio.

The eggs are deposited by the female beetle on the stalk near the surface of the ground, probably in May, June and July. The young grub bores into the base of the stalk and roots, changing from one straw to another. When full grown they change to a pupa in an earthen cell in the soil and the adult appears in late summer or during the fall, probably to pass the winter as an adult.*

This insect was common in the spring of 1895, in wheat fields in Monongalia county where it was quite a serious pest.

For remedies, preventives see No. 178.

THE LEAVES.

If leaves have a sickly appearance and covered with small insects, see Nos. 50, 51.

If leaves are partly or wholly consumed or have a ragged appearance, see No. 16, 17.

50. *The Green Plant Louse.*—See No. 56.

51. *The Chinch Bug.*—See No. 45.

Injury by Bugs and Plant Lice.

THE HEADS.

Heads die prematurely and have a whitish appearance, conspicuous among the green ones; have a ragged appearance; grain fails to mature; or heads destroyed.

If white heads appear, see Nos. 39, 40, 41, 42, 43, 49, 44.

If heads have a roughened appearance and the grain is shriveled, see No. 52.

If covered with plant lice, see No. 56.

If the grain is eaten out and the chaff is found on the ground, see No. 53.

If heads are cut off, see No. 57.

Injury by the Young of Gnats.

Kernels shriveled; the heads have a rough and unnatural appearance, and with small, orange colored maggots on the inner surface of the chaff or milky grain.

1. Sphenophorus sp (parcutus Gyll.?)

*A similar insect obeerved in timothy bulbs from Kanawha and Monongalia counties in May 1896.

52. *The Wheat Midge.*[1]—An orange yellow maggot from an eighth to a tenth of an inch long, absorbing the substance from the young kernel, causing them to shrivel and become worthless; adult, a minute gnat or midge.

The eggs are deposited by the midge in the crevices of the chaff about the time the wheat is heading; the maggots hatching from the eggs crawl within and feed upon the flowers or milky juices of the kernel by absorption or sucking; when the maggots are matured they leave the heads and enter the ground where they remain over winter to appear as adults in the spring.

This insect was extremely common and destructive in West Virginia some twenty to thirty years ago, but of late years, it has not to our knowledge, done much damage.

For preventives, remedies, etc., see Nos. 170, 183, 184.

Injury by the Young of a Moth and by Grasshoppers.

Heads and young grain eaten by smooth, striped worms, or by grasshoppers, and chaff scattered on the ground.

53. *The White Head Army Worm*[2].—When quite young a light colored worm with a black head, found feeding on the leaves; at maturity it is striped with yellow and brown; about one inch long, and feed on the milky kernels of the heads.

The eggs are laid on the stem of the wheat in rows near the base of the leaves; the young worms hatch from the eggs in about five days, when they feed on the leaves, and when about half grown, attack the milky kernels in the head; they enter the ground or conceal themselves beneath rubbish to change to the chrysalis stage; the moths appear the following May.

This insect has not been observed by us or reported in West Virginia, but doubtless occurs in this State.

For preventives, remedies, etc., see Nos. 181, 182, 245.

54. *The Angoumois Grain Moth.*—The young feed on the grain in the field, see No. 85.

Preventive No. 188.

55. *The Wolf Moth*[3].—Similar to the above, but the worm spins a web over the grain and portions of the head.

Preventive No. 188.

Heads covered with small greenish lice.

56. *The Grain Louse*[4].—A small, soft bodied, pear-shaped, greenish plant louse, sucking the vitality out of the forming kernels; causing them to shrivel; the young and some of the adult lice are wingless, while part of the adults have wings.

The winged females deposit eggs on the young wheat in the fall; the eggs hatching in the spring into female lice, which soon give birth to living young.

1. Diplosis tritici, Kirby.
2. Leucania albilinea, Guen.
3. Tinea granella, Linn.
4. Siphonophora avenæ, Fab.

each at the rate of five or six a day, and seventy-five to one hundred before they die. The young commence to reproduce in a few days after they are born, and so on through the summer, increasing at an enormous rate if all the conditions are favorable. They live on the blades and heads of wheat and other small grain until it is harvested, when they change to other similar plants and to the volunteer wheat, oats, etc., upon which they feed and breed until the young winter wheat appears in the fall. At this time a generation of winged males and females appears, and the females deposit eggs on the winter wheat for the spring brood.

This is an exceeedingly common insect in West Virginia, appearing at times and in certain sections in enormous numbers, causing serious damage to the wheat crop, and loss to the growers. It was reported from Marion, Mineral, Hampshire and Wood counties in 1890 and 1891, where it was unusually abundant.

For preventives, remedies, etc., see Nos. 170, 246.

Injury by the Young of a Small Bee.

Small worm mining in the straw causing it to break off just below the head.

57. *The Wheat Head Pruner*[1]—A small worm resembling the wheat saw fly worm: the young of a four winged saw fly which we have termed the Wheat Head Pruner to distinguish it from its near relative, and on account of its habit of cutting off the upper joint of the straw, just below the head, the worm living in lower portion of the stalk or straw. It did considerable damage in New Jersey and Pennsylvania in 1886 and 1887.

This insect has not been observed by us or reported in West Virginia, but there is no apparent reason why it should not occur in this State.

STORED GRAIN.

Stored grain damaged by having outer portions of the kernel eaten, or interior hollowed out; sometimes covered with webs rendering it worthless for ordinary use.

If the exterior of the kernel is gnawed and the inner portion partially or wholly consumed, without webs, see No. 58.

If exterior is not gnawed, but interior consumed, with round holes in the kernels and some of the kernels are webbed together, see Nos. 60 a, 61.

Injury by Beetles and Their Young.

The kernels gnawed from the outside by the adults, and the young developing within the kernel.

1. (?) Dolerus sp.

58. *The Granary Weevil*[1]—A small, brown and shining, flattened-snout beetle, from an eighth to a sixteenth of an inch long. The head is prolonged into a snout with which it punctures the kernels, and eats into the outer portion. The young form is a minute, footless grub.

The eggs are deposited in the punctures and the grubs hatching from them feed upon the inner portion of the kernel where they transform to the beetle about six weeks from the time the eggs are deposited.*

This insect often does immense damage to stored wheat, corn and other stored products in this country and Europe. It has not been observed or reported in West Virginia, but doubtless occurs in this State.

For preventives, remedies, etc., see Nos. 190, 191, 216, 232.

59. *The Rice Weevil*[2].—A small, brownish snout beetle, one-tenth to a sixteenth of an inch long, with four more or less distinct red spots on its wing covers; similar in other respects and in habits to the preceding species, except that this species is a more general feeder, attacking rice and all of the smaller grains, the adult often infesting crackers and cakes.

It is a common insect in West Virginia, and especially injurious to corn and wheat that has been stored in one place more than one year.

For preventives, remedies, etc., see No. 190, 191, 192, 216, 232.

60. *The Saw-Toothed Grain Beetle*[3].—A slender flattened, reddish-brown beetle, one-tenth of an inch long, with six, saw-like teeth projections along each side of the middle portion of the body, (the thorax.) It feeds upon the outer portion of the kernels and the germ. The young is a minute, slender, active worm, feeding on the outer and inner portion of the kernel and changing about from one kernel to another. A brood of this beetle may develop every 24 to 40 days.*

This is a common insect in West Virginia and is a general feeder, attacking all kinds of grain, kernels of nuts, candies, museum specimens, etc., and is a serious pest.

For preventives, remedies, etc., see Nos. 190, 191, 192, 216, 232.

Injury by the Young of Moths.

Interior of the grain consumed by small worms and the injury accompanied with webs.

60*a*. *The Angoumois Grain Moth Worm.*—Attacking the grain in the field, in the shock, stack and granary. See No. 85.

1. Calandria granaria, Linn.
2. Calandria oryza, Linn.
3. Silvanus surinamensis, Linn. *Compiled

61. *The Mediteranean Flour Moth Worm*[1].—A small caterpillar, or worm similar to the preceding, except that it is sparsely covered with long hairs. This is a serious pest, attacking grain and flour in mills in Canada and portions of New York.

This insect has not been observed in West Virginia but millers should keep a sharp lookout for it.

Its presence in mills may be known by the machinery becoming clogged with masses of flour and bran.

If this condition should occur in any of the flouring mills in the State the fact should be reported to the Experiment Station in order that we may assist in preventing the spread of the pest.

For preventives, remedies, etc., see Nos. 190, 191, 192, 216, 232.

INDIAN CORN.

The Seed in the Ground.

The corn fails to come up.

If the grain is hollowed out and the meal left about in the soil, see No. 62.

If the grain is gnawed from the outside, see Nos. 63, 64.

If holes are bored through the kernels, see Nos. 63, 65, 66.

Injury by Ants.

62. *Ants*[2].—Two kinds of ants have been recorded as attacking and injuring the seed in the ground. As a rule, however, ants in the soil with the sprouting and growing seed indicate the presence of plant lice. See No. 71.

Injury by the Young of Beetles.

Mining into and consuming the kernels.

63. *Wire Worms.*—Nine kinds of wire worms are said to attack the seed in the ground. See No. 2.

64. *Two other kinds of worms* are noted by Forbes[3] as injuring the seed in the ground, one[4] of which is common in West Virginia, but is usually found in the bark of trees or feeding on sap, and is

1. Ephestia Kuehniella, Zell.
2. Solenopsis debilis, Mayr.
2. Myronica scabrinodis lobicornis, Nyl.
3. Forbes' 7th Rep't, Insects of Ill.
4. Ips fasciatus.

supposed to be more beneficial than injurious. The other one[1] has not been observed or reported in West Virginia.

For remedies and preventives see Nos. 208, 202.

Injury by the Young of Flies or Gnats.

Maggots mining into the grains, feeding upon the germs and inner substance after the kernels have become soft from laying in the ground.

65. *The Seed Corn Maggot*[2].—A whitish or yellowish maggot with larger end dark, about one-fourth of an inch long, changing to a fly resembling the house fly.

It has not been observed or reported in West Virginia, but doubtless occurs here.

For preventives, remedies, etc., see Nos. 176, 208, 195.

66. *Black-headed Grass Maggot*[3].—A small, slender, white worm, one-tenth to one-fifth of an inch long, with jet black head; infesting the soft kernels and converting the inner substance into a paste-like substance, changing to a two winged gnat.

Cool, wet weather following corn planting, favors the attack of this insect; also stable manure in the hill would offer favorable conditions for its presence.

There are numerous species of this class of insects, known as fungus gnats, but have not been observed or reported as attacking corn in West Virginia. That they may do so in favorable seasons for their occurrence, there can be no doubt. I have observed similar worms in orange seeds, planted in the greenhouse; and the potato scab gnat and other species of the same class were seriously injurious to potatoes in the hill, in different sections of the State, in 1891–2. See No. 87.

For remedies, preventives, etc., see Nos. 208, 176, 195.

THE ROOTS.

Young plants of a dwarfish appearance, in patches over the field, with the lower leaves of a yellowish or reddish hue, stop growing when about a foot high, or die.

If roots and base of stalk are consumed, see No. 67.

If holes are bored into roots and base of the stalk, see No. 68.

If some of the roots are dead, others decaying at the ends, or longitudinal, brown lines occur on the roots, see Nos. 69, 70.

1. Systena taeniata.
2. Anthomyia Zeae, Riley.
3. Sciara sp.

If ants are observed around the plants and the roots are dead or shriveled, and small, bluish, soft-bodied insects covered with a whitish substance are found on or near the roots, see No. 71.

Injury by the Young of Beetles.

White, grubs or white worms consuming or mining into the central and smaller roots, or consuming and mining into the base of the stalk of young, growing corn.

67. *The White Grubs.*—These are serious enemies to the roots of corn, cutting off the main and lateral roots, and thus checking the growth of the plant, or killing it. For further description see No. 1.

68. *The Wire Worms.*—Are also destructive to the young corn mining in the roots and base of the stalk. For further description, etc., see No. 2.

69. *The Northern Corn Root Worm.*[1]—A slender, white worm, two-fifths of an inch long, with head and tail end yellowish brown; mining in roots of corn; consuming them or causing them to decay; the young of a small greenish beetle that feeds on the pollen of corn and other plants. The eggs are deposited by the beetle about the roots of cornstalks and stubble in the late summer or fall, and hatch the following spring, to attack the young corn if planted in the same land. The worms feed upon the roots until August, when they change to the pupae and shortly after the adult emerges.

This is a destructive pest in the North and West, but has not been observed or reported in West Virginia as doing damage to corn.

For preventives, remedies, etc., see No. 178.

70. *The Southern Corn Root Worm*[2]—A small, slender, whitish worm, somewhat larger than the preceding, mining and feeding upon the roots; the young of a common, small, yellowish green beetle, with twelve black spots on its back, found feeding on the leaves of plants; closely related to the striped cucumber beetle; life history not fully known.*

This is an exceedingly common insect in West Virginia, and the larvae doubtless do considerable damage to the roots of corn and other plants, while the adult is classed among our injurious, leaf-eating insects.

For preventives, remedy, etc., see No. 202.

Injury by Plant Lice.

Roots deadened or dwarfed without external injury. Eight kinds of plant lice are known to attack the roots of corn, of which

1. Diabrotica longicornis, Say. *Compiled.
2. Diabrotica 12-punctata, Oliv.

the *Corn Root Louse*, No. 71 and the *Grass Root Louse*, No. 6, are especially injurious.

71. *The Corn Root Louse.*[1]—A small, bluish green, pear shaped, soft-bodied insect, with a whitish substance covering the body, and with mouth parts formed for sucking, by which it pierces the roots and sucks out the sap or liquids. The young forms and the adults are wingless, except a brood that appears in May.

The eggs of this plant louse which are deposited on or near the old roots, in the fall are collected by the corn louse ant* and taken to its nest where they are stored until spring, when the ants transfer the eggs or young lice to the roots of smart weed and pigeon grass and then to corn, and are there cared for and protected by the ants. In return for this indispensable service the plant lice furnish a quantity of honey-like liquid from two tube-like projections on the hinder parts of their bodies upon which the ants feed. All the lice hatching from the eggs are females and they multiply at an enormous rate, each female having young without the intervention of males, at the rate of about one every two or three hours, and the offsprings, which are also females, commence having young when they are a few days old. The ants transfer the lice from plant to plant to form new colonies. This process proceeds until fall, when the males appear and the last brood of females lay eggs which are cared for by the ants, as previously stated.

Thus, the ants contribute quite as much to the trouble as do the plant lice themselves.

This insect and its benefactor, the ant, are common insects in portions of West Virginia, and in one section, near Ripley Landing, in Jackson county, they were found to be exceedingly common and destructive to corn, in May, 1891.

For preventives, remedies, etc., see Nos. 170, 178, 196.

THE STALK.

Young plants suddenly disappear or wither, central shoots die or wilt; small burrows or punctures in the stalk; or they have sickly appearance and covered with minute insects.

If plants are cut off above or beneath the surface of the ground, and the leaves are drawn into the soil, see No. 72.

If young plants wither or are cut off, and upon close examination a web is found at the base of the stalk, see No. 72*a*.

If the central shoot of young plants withers and dies and is easily pulled out, or holes are bored into the stalk after they are nearly full grown see No 73.

If young shoots are punctured before leaves unroll, and the leaves are filled with small holes, see No. 74; if large holes, see No. 80.

If the stalk has a diseased appearance, and is covered with small, greenish insects, see No. 76. If covered with minute, reddish and black insects, see No. 75.

1. Aphis maidiradicis, Fabr.
* Lasius brunneus.

Injury by the Young of Moths.

Portions or the whole of the plant consumed by worms that feed at night and remain in the soil through the day.

72. *Cutworms.*—These are among the worst enemies of the young growing corn. For further account of cut-worms see No. 7.

72*a*. *Web Worms.*—Living in a web at the base of the young stalks where it feeds upon and kills the plant. For further account of these insects, see No. 8.

73. *The Stalk Borer.*[1]—A dark colored worm, one to one and a quarter inches long, with three white lines on the back the full length of the body; on some examples the stripes occur on the front and rear third with the central poriton black or brown; boring into the stalk of young corn, and at different points in the older stalk, mining in the pith; the worm changes to a chrysalis in the stalk, or in the ground, from which a yellowish moth emerges.

The eggs are deposited on almost all kinds of plants early in April and May, and as soon as hatched the young worms bore into the young stalk. If the stalk proves to be too small to accommodate it, it migrates to a stalk, either of the same or some other kind of plant that is larger. The worm changes to a chrysalis in its burrow in the plant in July and August, or in the soil, the moth appearing in the fall, or possibly the following spring.

There is possibly several kinds of worms having this same habit of boring in the stalks of plants, but so far only two have been recorded as attacking corn.

The stalk borer is a common insect in West Virginia and has been observed in corn and a great number of other plants. Small worms apparently of this same species are often found in the stalks of blue grass early in the spring, causing what is known as white top.

For preventives and remedies, see Nos. 171, 174, 230.

Injury by Beetles.

Young shoots punctured by a small beetle before the leaves unroll. After they have unfolded they show numerous small holes.

74. *The Sculptured Corn Curculio*[2]—A dark colored snout beetle about three-tenths of an inch long; head and legs black; feet reddish, and with snout one-third the length of its body; mining into the young shoots; a serious pest in some sections of the country*.

Probably occurs in West Virginia, but has not been observed or reported.

For preventives, remedies, etc., see No. 171.

1. Gortyna nitela, Guen. *Complied.
2. Sphenophorus sculptilis, Uhlr.

Injury by Plant Lice and Chinch Bugs.

Plants showing an unhealthy condition and stalks covered with reddish and black bugs, or the stalk of the ear covered with greenish lice.

75. *The Chinch Bug* —See No. 45.

76 *The Corn Aphid.*[1]—Dull green or redish lice covering the stalk that bears the ear; sucking the nourishment and preventing normal development of the grain, also occurring on the main stalk and the leaves.

For preventives, remedies, etc., see Nos. 170, 178.

THE LEAVES.

Leaves partly or wholly consumed, or exhibiting a diseased condition.

If leaves are partly or wholly consumed, see Nos. 77, 77*a*, 77*b*.

If the leaves exhibit a diseased condition and are covered with minute, reddish and black stinking bugs, see No. 78.

If covered with greenish or reddish plant lice, see No. 79.

77. *The Army Worm*,—not a common insect in West Virginia but liable to appear and do much damage, see No. 14.

77*a*. *The Locusts and Grasshoppers*,—nos. 16, 17, When common these insects are quite injurious.

77*b*. *Climbing Cutworms*,—(see No. 7,) may do some damage by cutting off the leaves.

Injury by Chinch Bugs and Plant Lice.

Plants have a sickly appearance from the loss of sap extracted by the bugs and plant lice.

78. *The Chinch Bug.*—See No. 45.

79. *The Corn Aphis.*—Plant lice, sucking the substance from the leaves, see No. 76.

THE EAR.

The growing ear injured, preventing perfect development, or causing diseased condition.

If the growing kernels are eaten and the burrowed spaces are filled with excrement, see Nos. 80, 81.

If stalks of ear and husks are covered with plant lice, see No. 83.

If covered with minute, reddish and black stinking bugs, see No 82.

1. Aphis maidis.

Injury by the Young of a Moth.

Burrows between the husk and cob by a worm; the young grains on the end of the ear eaten; the silk dead and the burrows filled with excrement.

80. *The Corn Ear Worm.*[1]—A pale green, or sometimes brownish worm, one to one and a quarter inches long when full grown; burrowing into the end of the ear and consuming the young grain; changing to a chrysalis in the ground and then to a moth.

The moth deposits her eggs on the silk of the forming ears; the young worms hatch from the eggs and mine into the ear and feed upon the succulent kernels until they are fully developed; then they leave the ear and go into the ground, where they change to a chrysalis, remaining thus about two weeks, when the moth emerges. A brood of moths appear in the spring from the chrysalis that remained in the soil over winter. There are probably three broods of this insect in a single season. In the South, where cotton is grown, it is known as the Cotton Boll Worm.

This is a common insect in West Virginin and often does immense damage, especially to sweet corn. It also attacks young beans, peas, tomatoes, etc. In the spring of 1895 the moth appeared before there were any ears forming, and it deposited it eggs on the central shoot of the young corn plants and the worms did considerable damage by boring into and consuming the tender blades. The leaves that were not cut off by the worms showed rows of holes across them when they unfolded. It also was quite injurious to bunch bean and peas, see but the corn was was damaged very little by it that season.

For preventives, remedies, etc., see Nos. 181, 178, 228.

Injury by Beetles.

The young kernels are consumed but the spaces are not filled with excrements, as is the case when the injury is caused by the corn worm.

81. *The Indian Cetonia*[2].—A brownish, hairy beetle, two thirds of an inch long by two-fifths of an inch broad, head dark, wing covers yellowish-brown, with pearly and metallic tints; under side of the body black and hairy; emiting a strong odor when handled; resembling a bumblebee when flying; appears early in the spring; common on flowers, and feeds upon young corn and ripe fruit. The young form is a white grub, but its life history has not been worked out.

It is a common insect in West Virginia.

For preventives, rememedies, etc., see No. 228.

Injury by Chinch Bugs and Plant Lice.

82. *The Chinch Bugs.*—Attacking the stalk of the ear and the husk prevents perfect development of the ear, see Nos. 45, 76.

1. Heliothis armiger, Hubn.
2. Euphoria inda, Linn.

83. *The Corn Aphis.*—Attacks the stalk of the ear and the husk and does some damage. Its habits and life history are similar to that of other plant lice,* see No. 56.

THE STORED GRAIN.

Stored grain damaged by having outer portions of the kernel eaten, or interior hollowed out and sometimes covered with webs, rendering it worthless for ordinary use.

If the exterior of the kernel is gnawed and the inner portion partially or wholly consumed—without webbs—see Nos. 83*a*, *b*, *c* and 84.

If interior of kernel is wholly or partly consumed, with round holes in the outer end, and the injury is attended with web, see No. 85.

Injury by Beetles and their Young.

Adults gnawing the grain from the outside and the young developing within the kernel.

83*a*. *The Granary Weevil.*—See No. 56.
83*b*. *The Rice Weevil.*—See No. 59.
83*c*. *The Saw-toothed Grain Beetle.*—See No. 60.

84. *The Caddle*[1]—An oblong, depressed, bark-brown beetle, about a third of an inch long. The young is a whitish, fleshy worm with a black or brown head, and dark spots in the three segments back of the head, and with two horny, curved projections on its tail end Both the adult and the larvae feed on the grain,—the beetle feeding upon the outer portion and the larvae hollowing out the kernel, moving from one kernel to another along the cob, and finally changing to a pupa in one of the kernels; the adult emerges through a large opening in the outer end. Corn infested by this insect has the appearance of having been eaten by mice. Some ears of corn infested by this insect and the saw-toothed grain beetle were sent to the Station by W. Harrison Pyles. Hebron, Pleasants county, W. Va., who reported that considerable damage had been done to corn that had been kept over one year.

Remedies, Nos. 190, 191, 216.

Injury by the Young of Moths.

Character of injury similar to that of the Granary Weevil and Rice Weevil, except that there are a few webs present, more or less adhering to the kernels.

*Compiled.
1. Penebroides muritanicus, Linn.

85. *The Angoumois Grain Moth.*[1]—The larva smooth, white worm with head and first segment of body brownish; about two-fifths inches long; feeding within the kernels and boring holes through the shells from which the moths escape. The adult resemble the common clothes moth.

The eggs are laid between the rows of kernels on the ear in the field or granary, and the young worms bore into the kernel where they feed and develop in about three weeks to their full growth, then changing to the chrysalis, and the moth, the latter emerging in about 30 to 40 days after the eggs are deposited.

This is a common insect in West Virginia and is a general feeder upon grain and other similar substances.

For preventives, remedies, etc., see Nos. 188, 190, 191, 216.

THE POTATO.

THE PLANTED SEED TUBERS.

The potato fails to come up, and if upon examination the eyes, or young sprouts, or the tuber has been eaten or is hollowed out, presenting a decayed appearance, it may be caused by insects.

If the surface is gnawed and the vital portions eaten away, see Nos. 85*a-b*.

If presenting a decayed appearance and without odor, or the interior portion worked into a paste like substance, see No. 86.

Injury by the Young of Beetles.

85*a*. *White Grubs.*—(see No. 1,) may attack the seed tubers and damage them so they will fail to grow.

85*b*. *Wire Worms.*—(see No. 2,) may also do similar damage.

Injury by the Young of Gnats.

86. *The Fungus Gnats*, (see No. 88) may do some damage. They at least breed in seed tubers in the ground and are thus brought in contact with the growing tubers which they may attack and cause serious damage. See No. 55.

THE GROWING AND MATURED TUBERS IN THE HILL.

Tubers injured or destroyed; injured by surface blemishes other than that caused by fungus scab; destroyed by having all or part of the tuber but the skin converted into a starchy, pasty or mealy substance, or a decayed condition not the result of diseased germs.

If a small or large cavity occurs, partly or entirely covered by the thin skin of the tuber, or with portions of the skin projecting

1. Gelechia cerealella, Ol.

from the edges of the cavity, and the interior of the cavity when washed out shows a smooth, pitted surface, or minute, slender, white worms with black heads are found in the pits. See Nos. 87, 88.

If ordinary fungus scab spots contain a whitish, mealy substance, and minute smooth, round bodied objects are common beneath, or in this substance, see No. 89; if white worms, see No. 87, 88.

If portions of the surface of the tuber is eaten away and the surface of the wound has a healthy appearance and shows minute tooth marks, see No. 90.

If round holes are bored into the skin and deep into the tuber, or entirely through it, see No. 91.

If the tubers have the appearance of being affected by the rot disease, but are free from an unnatural odor and a paste like, or a mealy substance occurs within the skin, see Nos. 87, 88.

Injury by the Young of Gnats.

Minute, whitish worms, with black heads, feeding in decayed spots in the tubers, also upon the healthy substance of the tuber.

87. *The Potato Scab Gnat Worm*[1]—A minute, white, slender worm, one-sixth of an inch long; consuming the healthy substance of the tubers, causing one form of the potato scab, or a condition resembling rot; changing to a wingless female and a winged male gnat.

The eggs are deposited by the gnat on stored tubers in the cellar during the fall, winter and spring. The young worms enter the old scab spots or slightly injured places, and under favorable conditions a brood is developed every twenty to twenty-five days. In the spring the gnats deposit their eggs in stable manure or other decaying vegetation, or on the seed potatoes and growing tubers in the hill to which they may have been transferred on the seed tubers or in vegetable matter.

Here the young worms may attack the healthy skin of young tubers, but preferably where the skin has been in any manner slightly or seriously injured, or where scab spots are being formed by the scab fungus. Once within the tuber and the conditions remaining favorable the potato is destroyed by them, but if the worms are driven out by their natural enemies, or the soil becomes so dry that they disappear, the places infested by them will show nearly the same characters as the ordinary scab, and may be easily mistaken for it.

Favorable conditions for the occurrence of this insect in injurious, or destructive numbers, and for their attack upon potato tubers in the store room or in the soil are moist, warm cellars in which potatoes are stored, and prolonged, cool wet weather in the

1 Epidapus scabiei, Hopk.

spring, summer or fall. They cannot exist, or at least thrive in dry soil or in a perfectly dry store room.

During the summer of 1891 and 1892 this insect and its near relatives, the fungus gnat worms, were especially common in Wood and Monongalia counties; and from personal study, observation and reports I am confident that immense loss of potatoes was caused by them during these years, in different sections of the State. Tubers received from Philadelphia contained great numbers of the insects, which is evidence that they were common in other sections of the country, as well as in West Virginia.

It must be remembered that while the potato scab gnat worms cause forms of potato scab, and may effect serious loss by extending injuries resulting from other causes, they are by no means to blame for all kinds of potato scab, since it is well established that a fungus discovered by Dr. Thaxter is the prin e cause of the commoner forms of the scab.

The gnats may, however, under favorable conditions be more destructive than the fungus on account of their habit of penetrating deep into the substance of the tuber, thus rendering it worthless.

For preventives, remedies, etc., see No. 170, 178, 176, 208, 194, 195.

88 *The Fungus Gnat Worms.*[1]—A number of worms, similar in general appearance to the potato scab gnat worms, but larger and both sexes of the adults have wings. The habits of all of the fungus gnat worms that infest the potato tubers are similar and the same general treatment answers for all.

Injury by Mites.

Small round bodied white objects in scab spots feeding on diseased or healthy substance of the tuber.

89. *Mites*[2] -Small, round bodied, eight-legged objects, related to spiders, feeding in scab spots and extending the injury, but it appears that they are not capable of causing a scab, and the injury caused by them is not of a serious character. In fact, the presence of this little creature appears to be disagreeable to the scab gnat worms, since they appear to be driven out by them when the mites become numerous.

Injury by the Young of Beetles.

Cavities gnawed in the outer substance by grubs, or holes bored into or through the tuber by worms.

90. *White Grub Worms* (See No. 1).—Often do considerable damage to growing potato tubers.

1. Sciena sp.
2. Order *Acarina*.

91. *The Wire Worms* (see No. 2) also attack and bore into potato tubers.

THE STALKS.

Stalks wilt and die; holes bored into them, or the inner portion is hollowed out.

If a small, whitish grub is found in the burrows, see No. 92; if holes are bored into the stalk or a black and white striped worm is found in the burrows, see No. 93.

If stalks are cut off near the ground, see No. 94.

Injury by the Young of a Beetle.

92. *The Potato Stalk Borer.*[1]—A whitish, legless grub, one-fourth of an inch long when fully developed; mining in the stalk near the ground, causing the stalk to wilt; the adult a small, grayish, snout beetle.

The female beetles lay their eggs in a slit made for the purpose just above the surface of the ground. The eggs hatch in a few days and the worms boring into the heart of the stem mine downward towards the roots. In a few weeks they change to the pupa within the stalk, and late in summer emerges as adults. In this stage the insect passes the winter in the stalk or any secluded place it can find. It also breeds in the stalk of various weeds.

This insect has not been observed or reported in West Virginia. For preventives, remedies, etc., see Nos. 173. 230, 232.

Injury by the Young of a Moth.

93. *The Stalk Borer.*—(See No. 73.)—A black and white striped worm mining in the stalks.

94. *Cutworms.*—(See No. 7.)—These insects were serious enemies to young potato plants in the spring of 1895, especially in Jackson county, W. Va., where they kept the tops cut down over large fields.

THE LEAVES.

Leaves consumed; punctured with minute holes, or have a curled and sickly appearance.

If leaves are partly or wholly consumed and infested with reddish, soft, round-bodied insects and hard shelled, yellow and brown striped beetles, see No. 96.

If leaves have a ragged appearance, infested by long bodied, black or striped active beetles, see No. 97.

If infested by large green worms with long spine on their tail ends, see No. 100.

If leaves are punctured with small holes, or the surface eaten in spots, see No. 98.

1 Trichobaris trinotrata, say.

Injury by Beetles and their Young.

Leaves partly or wholly consumed and the bare stalks left standing, see No. 61; or have a ragged appearance, see No. 62; or punctured with small holes, see No. 63.

96. *The Colorado Potato Beetle.*[1]—A thick-set, brown and yellow striped beetle, too familiar to every potato grower to need further description, as is the variegated red, soft bodied, hump-backed young form of this, one of the worst potato pests known.

As soon as the potato appears in the spring the beetles lay their orange colored eggs in patches usually on the underside of the leaves. These hatch in about a week into venetian red creatures that at once begin to devour the plant. As the young grow they become lighter in color, and plainly show two rows of spots on each side of the body. Reaching full growth in two or three weeks, they leave the plant and burrow into the soil where they change to the pupæ, thence to the adult. They now emerge from the ground and provide for another generation, there being three or four during the year. The pest hibernate as adults and pupæ.

For preventives, remedies, etc., see Nos. 229, 231, 202, 242, 245.

97. *The Blister Beetles.*[2]—Seven species of blister beetles are known to attack the potato leaves, but there are only three kinds that are especially common and destructive to potatoes in West Virginia, namely, the *Pennsylvania Blister Beetle*,[3] a uniform black species; the *Ash Colored Blister Beetle*,[4] with a variety of the same known as the *Margined Blister Beetle*. The third species is the *Striped Blister Beetle*,[5] which is yellowish with front part of the body marked with black and with two black stripes on the wing covers. All have similar habits in feeding upon potato, beet, tomato and leaves of other garden plants, and are common on the flowers of the goldenrod and aster. They are very active in using their legs, but seldom resort to flight, although they have well developed wings. These insects are widely distributed throughout the country and belong to the same family as the Spanish Fly of Europe, in fact, derive their name from the blisters they cause when the liquids of their bodies come in contact with the skin of of the hands or other parts of the person.

The eggs of these insects are laid in the ground where the young remain feeding principally on grasshopper eggs, and it is only during the adult stage that they are injurious.

These are common insects in West Virginia and often prove serious pests, especially during the year following one in which grasshoppers or locusts were common.

For preventives, remedies, etc., see Nos. 202, 224.

1. Doryphora decemlineata, Say.
2. Numerous species belonging to the genus (Lytta.) Epicauta.
3. E. Pennsylvanica.
4. E. cinera.
5. Epicauta vittata.

98. *Flea Beetles.*—A number of species of flea beetles attack the potato leaves, all having somewhat similar habits. They are small, black or brown beetles, varying in size from one-sixteenth to one-eighth of an inch long, jumping like a flea when disturbed.

The young mine in the leaves or roots of different plants, but their life history is not well known

A black and small brown species are quite common on potato leaves in West Virginia, but as a rule, the damage is not very great.

For remedies, see Nos 202, 207, 212.

99. *Three Lined Leaf Beetle.*[1]—Young somewhat similar to that of the Colorado beetle, but covered with a cloak composed of their excrements. The adult is a three lined beetle, resembling the *cucumber beetle. It has not been reported from West Virginia.

For remedies, see Nos. 202, 228.

Injury by the Young of Moths.

100. The Horn Worm[2].—A large green worm with a horn on tail end; the adult is a large bodied moth common in West Virginia, feeding upon the potato, tomato and tobacco.

See also No. 167

102. *Cutworms.*—(See No. 7.)—Climbing cutworms may do considerable damage by cutting off the leaves at night.

STORED TUBERS.

Tubers converted into a condition resembling decay.

103. *The Potato Scab Gnat Worm.*—See No. 87.

104. *Fungus Gnat Worms.*—See No. 88.

These insects often do serious damage when potatoes are stored in damp cellars, the trouble often being attributed to ordinary decay or potato rot.

Preventive, a dry store room.

SWEET POTATOES.

THE ROOTS AND TUBERS.

Roots gnawed or mined.

Injury by the Young of Beetles.

105. *The White Grubs,*—(No. 1.) often attacks sweet potatoes and gnaws cavities in them.

1 Lema trilineata Oliv
2 Phlegethontius (Sphinx) celius.
" carolina.
*Compiled.

106. *The Wire Worm*,—(No. 2) also attacks the tubers.

THE STALK.

Young plants cut off at the surface of the ground at night, and consumed.

107. *Cutworms*.—(See No. 7.) The sweet potato plant is the favorite food of certain kinds of cutworms, and they often do much damage and cause serious loss to sweet potato growers in West Virginia.

THE LEAVES.

Leaves have irregular holes eaten into them and completely riddled; surface eaten away in spots and strips.

If leaves have a ragged or riddled appearance with odd looking insects on them, (see No. 108.)

If the surface of the leaves is eaten away in spots and strips, (see No. 109.)

Injury by Beetles and Their Young.

Leaves gnawed and ragged, and on the underside odd looking insects of various sizes are found feeding.

108. *Tortoise Beetles*,[1]—The five different species of these small beetles, that attack the potato range from one-fourth to three-tenths of an inch in length; some species shining like gold, others with bright, metallic luster, and closely resembling a turtle in miniature. The young are broad and flat, with many radiating spines and a forked tail which retains their cast off skin and excrement. This tail forms a covering or parasol for the insect which is carried over the back.

The eggs are laid singly upon the leaves and held in place by a sticky substance which the insect secretes. The larvæ feed almost exclusively on the under side of the leaves, and reach full growth in about three weeks, then they fasten the last two or three segments of the body to a leaf, and in a couple of days change to pupæ. In about a week the adult emerges. The winter is passed in the adult stage*.

These insects are common in West Virginia, and are the worst enemies of the sweet potato, often causing much damage when this crop is grown.

For preventives, remedies, &c., see Nos. 202, 228, 236.

Injury by Flea Beetles.

Small flea beetles feeding upon the surface of the leaves.

1. Several species belonging to the genus Cassida.
*Compiled.

109. *The Flea Beetles.*-(See No. 98.)-Quite a serious pest, feeding upon the surface of the leaves and often causing them to turn brown and die.

Common at Morgantown within the last few years.

For preventives, remedies, etc, see Nos. 202, 207, 236.

ASPARAGUS.

THE STALKS AND LEAVES.

Tender stalks with irregular, roundish spots eaten into them and the older plants defoliated or the bark eaten.

Injury by the Adult and Young of a Beetle.

110. *The Asparagus Beetle.*[1]—A pretty, red, yellow and shining black insect, about one-fourth of an inch in length; adult with head black; thorax tawny red with two more or less distinct black spots on its crown; wing covers lemon-yellow and black, with orange margin; young dull ash-grey or obscure olive; head black, and just back of it two shining spots; legs black.

This insect passes the winter in the adult state beneath bark, in crevices of wood and other sheltered places. As soon as the asparagus shows itself in the spring the beetles at once commence to feed upon it, and after pairing, deposit their eggs upon any portion of the shoots. In about eight days the eggs hatch and the larvæ feed vigorously upon the outer surface of the young shoots and reach full growth in about twelve days. They then leave the plant, and beneath the surface of the ground or simply under the leaves, make a slight cocoon in which they change to pupæ, and ten days later the beetles emerge.

There are probably three or four broods a season the last brood feeding upon the bark and leaves of the older plants.

This is an imported pest from Europe, and like other injurious insects that find their way to this country from foreign lands, is a serious pest in some sections of the United States.

It has not been observed or reported in West Virginia, but if it is not here, it will doubtless soon appear wherever asparagus is grown in any considerable quantity. Therefore, asparagus growers should look out for it, and, if possible, prevent it from becoming permanently established.

For preventives, remedies, etc., see Nos. 215*a*, 234, 241.

CABBAGE.

Cauliflower, Kohl-Rabi, Kale, Rape, Brussels sprouts, Turnips, Rutabaga, Radish, Etc.

THE ROOTS.

Plants checked in their growth, turn bluish, or suddenly wilt under the hot sun.

If rootlets are burrowed along their surface and the main root is mined or girdled, see No. 111.

1 Crioceris asparagi, Linn.

If the roots are cut off or eaten away, see No. 113a.

Injury by the Young of Flies.

Roots and base of stalk burrowed and containing whitish maggots.

111. *Cabbage Maggots* —White, cylindrical, footless maggots, about one-third of an inch long when full grown; living in the roots and stalk of cabbage and other nearly related plants; feeding upon the juices and seriously injuring and killing the plant; changing to two winged flies resembling somewhat houseflies, but smaller.

There are at least three kinds of these root or stalk boring maggots that attack the cabbage, turnip, raddish, etc., one that attacks the onion, No 169a and another attacking the corn, No. 55.

The European Cabbage Maggot[1], is by far the worst enemy to the roots of Cabbage. The following account of its life history applies also in a general way to the other species:

The flies appear in the spring about the time of setting cabbage plants. The eggs are placed near the surface of the ground close to the stem. They hatch in about a week, and the larvæ feed for about three weeks when they usually leave the roots and change to puparia in the soil near by. According to the different authors the duration of this stage varies greatly,—from two weeks to three months.

There are probably three broods of this pest during the season, the second generation changing to the pupae in July. The winter is evidently passed as flies, pupæ and maggots—the last mentioned in the old cabbage roots, the pupæ in the soil, and the flies in most any secluded place.

This is a very destructive imported enemy with which the cabbage grower has to contend, and is widely distributed, occurring in nearly every State of the Union and the Provinces of Canada, doing much damage not only to cabbage, but to other similar plants.

This and the radish maggot are quite common in West Virginia, but did not begin to attract much attention until the summer of 1890 and 1891, when the cabbage maggot proved quite destructive to cabbage plants along the Ohio Valley from Hancock to Wayne counties. But the radish maggot has been especially troublesome at Morgantown, for possibly seven or eight years.

For preventives, remedies, etc., see Nos. 173, 178, 197, 197f and 216.

112. *Fungus Gnat Worms*,—See Nos. 87 and 88.

These black headed worms were found quite common in turnips injured by the cabbage maggot in 1894, and from what is known of their habits they may, in connection with this insect, prove a troublesome pest, especially in wet seasons.

Injury by the Young of Beetles.

Roots cut off or injury similar to that caused by the cabbage maggot, affecting young plants.

1 Phorbia (Anthomyia) brassical, Bouch.

113. *Flea Beetles.*—Young of these beetles are small, elongated, six legged worms, boring in the roots or leaves of cabbage and other plants, often doing considerable damage to young plants. See 117.

113a. *White Grubs.*—See No. 1.

THE STALKS.

Plants cut off near the surface or some distance above the ground, or have a stunted, sickly appearance.

If plants or roots are cut off, see No. 114.

If they have a sickly appearance and the stalks are infested with maggots, see No. 116.

Injury by the Young of Moths, Beetles and Flies.

114. *Cutworms.*—The young of moths, (see No. 7) often cause serious damage to recently set out cabbage plants.

115. *White Grubs.*—The young of beetles, (see No. 1) sometimes consume the roots and a portion of the underground stalk

116. *The Cabbage Maggot*, (No. 111), also infests the stalk above ground.

THE LEAVES.

Leaves partly consumed; filled with small holes, or young plants suddenly disappear. Leaves on old plants curl up and have a sickly appearance or die.

If leaves on small plants are punctured with small holes, or the surface eaten off by minute, black insects with pale stripes, see No. 107.

If leaves are partially or wholly consumed and pale green worms are present, see Nos. 118, 121, 122. If yellow and dark striped worms, see No. 119. If large black and yellow striped worms, see No. 123. If bluish transverse striped worms, see No. 120.

If leaves have a wilted, sickly appearance and large bugs with yellow and red spots are common, see No. 128.

If leaves are curled down and the under surface is infested with plant lice, see No. 125.

Injury to Young Plants by Beetles.

Upper surface of the first leaves eaten by small pale striped beetle, causing them to wilt.

117. *The Wavy Striped Flea Beetle*[1]—A minute, shining, black beetle, one-tenth of an inch long, with two pale yellow, irregular stripes on the wing covers; feeding on the young leaves of cabbage and other related plants. The young live in the roots of the plants upon which the beetles feed.

1. Phyllotreta vittata.

A common and serious pest in West Virginia

For preventives, remedies, etc., see No 202, 212, 212a, 212b, 215a, b, c, d.

Injury by the Young of Butterflies and Moths.

Leaves partly or wholly consumed and presenting a ragged appearance.

118. *The Imported Cabbage Worm*[2]—A pale green worm, an inch or an inch and a quarter long, feeding on the inner tender leaves of cabbage and other related plants; changing to a common white butterfly. Front wings of Butterfly white, with black tips and black spots; hind wings grayish white, with one or two dark spots on each.

The females deposit their eggs usually upon the upper surface of the leaves; these hatch in about a week and the larvæ feed vigorously, becoming full grown in about two weeks. They generally leave the plant and find some sheltered nook where they change to the chrysalis stage, and in about ten days, during the summer, the butterflies emerge.

There are several broods during the season and the last one passes the winter in the chrysalis stage.

This is an exceedingly common cabbage pest in West Virginia, and causes serious loss and much annoyance.

For preventives, remedy, etc., see Nos. 197g, 202, 212 213, 245, 249.

119. *The Southern Cabbage Worm.*[3]—A greenish blue worm, somewhat over an inch in length when full grown; with longitudinal, yellow stripes. The young worms are yellow with black heads; a common cabbage pest before the imported species made its appearance, but has been extremely rare since the advent of its foreign relative, until last fall when it appeared again. This worm changes to a butterfly similar to the imported species, but has more black marking on the wings.*

The life history and habits are similar to that of the imported species.

For remedies, preventitives, etc., see Nos. 202, 245, 212.

120. *The Purple Striped Cabbage Worm, or Cabbage Pionea.*[3]—A smaller worm than either of the preceding, with transverse stripes of white and purple across its back; head shining, greenish yellow; under side of body pale green. It eats elongated oval holes in the leaves, gradually extending them until nothing but the larger veins remain; also bores into the heads; changing to a pupa in the ground, where it remains about twelve days, then changes to a pale, ochre-yellow moth with expanse of wings of about one inch.

2. Pieris rapae. schr.
3 Pontia (Pieris) protodice, Boisd.
4 Evergestis rimosalis.
*Not compiled.

This was an extremely destructive insect in the Ohio and Great Kanawha River valleys in 1890 to 1892, being more common and destructive than the imported green worms, No. 118. A parasite similar to that mentioned under No. 247 was common in 1891, but in many localities the bunches of small white cocoons containing the parasites were destroyed by gardeners who supposed they were the eggs from which the worms had hatched. It appears that this cabbage pest has been so completely subjugated by its parasite and by diseases that since 1892 it has been extremely rare.

For preventives, remedies, etc., see Nos. 202, 212, 213, 215d.

121. *The Northern Cabbage Worm*[1].—A light green worm, similar in appearance and habits to that of the imported species, changing to a white butterfly.

This insect is rare in West Virginia. With the exception of a number of specimens taken in the forest wilderness of Pocahontas county, on Black Mountain, I have not seen it in the State.

122. *The Cabbage Worm*; *Plusia*[2].—A pale green worm with paler longitudinal lines; feeding upon cabbage and other similar plants; changing to a moth that flies and deposits her eggs at night; not a serious pest in West Virginia so far as we have observed, but is quite a troublesome one farther south.

Remedy, same as for other cabbage worms.

123. *The Zebra Caterpillar.*[3]—Black worms when young; feeding in clusters on the leaves. As they grow older they disperse and when full grown measure nearly two inches in length, when it has reddish legs, and striped with velvet, black and yellow.

The adult is a moth. This caterpillar is quite destructive in some sections of the country, but not a common insect in West Virginia at least it has neither been observed nor reported from this state.

Remedy, same as for Cabbage Butterfly.

Injury by Bugs and Plant Lice.

Leaves infested with bugs sucking the liquids from the leaves causing them to wilt, turn yellow and die.

124. *The Harlequin Cabbage Bug or Calico Back*[4].—The adult is a gaudily marked insect, being variagated with black, yellow and red. It is about five-sixteenths of an inch long by three-sixteenths of an inch broad; the young resemble the adults except that they do not have wings; they feed upon the juices of the leaves by means of their sucking mouth parts.

The insect passes the winter in the adult stage under all sorts of rubbish and

1. Pieris oleracea, Boisd.
2. Plusia brassicae, Riley.
3. Mamestra picta, Harr.
4. Murgantia histrionica, Hahn.

about old cabbage stumps. In the early spring they leave their winter quarters and lay their eggs on mustard or other similar plants. The eggs are placed in double rows on the under side of the leaves. On reaching maturity this brood migrates to the cabbage field where it at once commences its work of destruction and lays its eggs for another brood. There are several broods during the season.

This is a comparatively new pest in West Virginia, but is spreading rapidly and is already a serious pest in certain cabbage growing sections. It appears that it originated in Texas from which it has gradually spread eastward and northward.

For preventitives, remedies, etc., see Nos. 181. 172, 173, 218, 221, 228.

125. *The Cabbage Plant Louse.*[1]—A greenish, soft bodied, pear shaped insect, usually covered with a whitish substance, often occurring in great numbers on the leaves, causing them to curl up and have a dirty, sickly appearance. It also attacks the leaves of all other plants nearly related to the cabbage. For the life history of plant lice see No. 56.

For preventitives, remedies, etc., see No. 170, 209, 212, 212a, 245, 243.

CUCUMBERS.

Melons, Squashes, Pumpkins.

THE ROOTS.

Plants fail to come up; young plants cut off or suddenly wilt and die; old plants suddenly die or have a dirty, sickly appearance.

If plants fail to come up, see Nos. 126, 127, 128.

Injury by the Young and Adults of Beetles.

Plants fail to come up and grub worms or wire worms are present; plants wilt and die; bark is eaten off, and striped beetles are present or small, white worms in the roots.

126. *White Grubs.*—(see No. 1.) Cutting the roots off.

127. *Wire Worms* (see No. 2.) Boring into the roots.

128. *The Striped Cucumber Beetle and its Young* (see No. 134.) Adult feeding upon the bark of the main root; the young mining into the roots, causing the plant to wilt and die.

THE STALKS.

Young stalks cut off by worms; bark eaten off by striped beetles; sap sucked out by bugs; stalk mined by a white worm.

1 Aphis brassicæ.

If young plants are cut off. See No 129*a*.

If young plants suddenly wilt and die and the surface of the leaves and stalks is eaten. See Nos. 130—134.

If old plants wilt and die. See No. 137.

If the leaves and vine wilt and the stalk of the vine is mined by a white worm, see No. 129. If not mined and covered with bugs, see Nos. 131—132.

If covered with lice, see No. 133.

If the base of the stalk is mined by minute, white worms, see No. 130.

Injury by the Young of a Moth.

A white worm mining the stalk or vine.

129. *The Squash Vine Borer*[1].—A whitish worm about one inch long when full grown, with brownish head; boring into the pith of the vines, causing them to wilt and die; changing to a pretty moth, with front wings olive brown, and hinder ones transparent, and with orange colored body, spotted with black.

The female moths lay their eggs upon the stem of the plants near the ground and the eggs hatching, the young mine into and feed upon the succulent interior. By the latter part of summer the larvae have reached full growth, and, leaving the vines, make cocoons in the soil where they change to the pupae and remain in that staffe until spring.

This insect is becoming a common pest in West Virginia.

For preventives, remedies, &c , see Nos. 172, 180, 181, 230, 232.

129a. *Cut Worms*, see No. 7.

Injury by Beetles and their Young.

The surface of the young stalk and old vines eaten by striped beetles, and the base of the stalk mined by minute, white worms.

130 *The Striped Cucumber Beetle.*—(See No. 134.) Adult feeding upon the young stalks and the bark of the vine; the young mine in the base of the stalk.

Injury by Bugs and Plant Lice.

Sucking the sap from the stalk and vine; large black or small grayish bugs and green plant lice.

131. *The Squash Bug.*—(See No. 137.) Adult and young sucking the sap from vine, causing it to wilt.

132. *The False Chinch Bug.*—(See No. 139.) Adults suck the sap from the tender shoots.

133 *Plant Lice.*—(See 128.) Sucking the sap from the tender shoots.

1. Melittia ecto. Westw.

THE LEAVES.

Surface of leaves eaten by striped and small black beetles; sap sucked from leaves or older by black and grayish stink bugs, or greenish plant lice.

If young plants suddenly wilt from being eaten, see No. 134.

If surface of young and old leaves are eaten, see Nos. 134, 135, 136.

If plants have a sickly, dirty appearance, and the leaves are covered with plant lice, see No. 138.

If covered with stink bugs, see No. 137.

If the tip of the vines are infested with small, grayish bugs that suddenly disappear when disturbed, see No. 139.

Injury by Beetles and Their Young.

Leaves of young and old plants eaten by striped and spotted beetles and the leaves mined by small, white worms.

134. *The Striped Cucumber Beetle.*[1]—A yellow beetle about one-fourth of an inch long, with two black stripes on each wing cover and a black head; feeding upon the surface of the leaves, vine, base of stalk and roots, killing or seriously injuring the plant. The young, or larva, is a small, slender, white worm, about one third of an inch long and the thickness of a pin, with head and tail black.

The adult makes its appearance early in the season, even before the vines are through the ground, and immediately begins its work by entering the soil through cracks made by the young plants as they are pushing their way out into the sunlight, and deposits its eggs on the roots and also feeds on the tender plantlet. As the plants grow the beetles continue to feed and deposit eggs, but, by perseverance and proper nursing, the vines are kept alive until they appear to be strong enough to withstand the attack of the beetle. At this time the insects also seem to diminish in numbers and the trouble is apparently over, when the vines suddenly begin to wilt, which, usually, is due to the larvae that have hatched from the eggs laid by the beetles, and mining into the roots. The larvae reach full growth in about four weeks, when they leave the roots and make little cells in the soil near by, and in about three weeks later emerge as beetles.

The winter is passed in the adult stage under old rubbish and other secluded places, from which the pest emerges in early spring and is ready for its work of destruction as mentioned above.

There are two or more broods of this insect; the late brood feeding upon the leaves and the bark of the vine and roots; also upon the young fruits. It often occurs in immense numbers on immature melons, pumpkins, etc., late in the fall. This appears to be a common and destructive vine pest wherever the cucumber and its nearly related plants are grown.

1. Diabrotica vittata, Fabr.

For preventives, remedies, etc., see Nos. 198, 212b.

135. *The Twelve Spotted Cucumber Beetle.*[1]—A beetle nearly related to the striped species and of about the same size, but with black spots on each wing covers in place of the two stripes. It also has similar habits of feeding on the leaves and breeding in the roots, but being a more general feeder on the leaves and roots of various other plants; it is not nearly so destructive to the cucumber family of plants as the striped species. The young of this insect is a serious corn pest. See No. 70. Preventives and remedies the same as for the striped species.

136 *The Cucumber Flea Beetle.*[2]—A small, black flea like beetle, about one-tenth of an inch long, with yellow antennæ and legs, feeding upon the surface of the leaves.

The young is a slender, whitish worm, mining in the leaves of the vines and possibly of other plants.*

This is an extremely common insect in West Virginia, attacking the leaves of potatoes, tomatoes, and many other kinds of plants, as well as those of the cucumber family.

For remedies and preventives, etc., see Nos. 202, 212b, 207, 204.

Injury by Bugs and Plant Lice.

The sap sucked from the leaves by large black or small grayish stink bugs and green plant lice, causing the leaves to wilt or turn yellow and die.

137. *The Squash Bug.*[3]—Adult a flattened stink bug, about one-half an inch long, of a rusty, black color on the back, and the under side of its body yellowish; emitting a very repulsive odor when crushed. The young, which are called nymphs, are of various sizes from minute, louse like creatures to the size of the adult; of a grayish color and resembling the adults, except that they are wingless when quite young; they feed in clusters on the leaves by sucking the juices.

The eggs are deposited from late spring until fall in clusters on the under side of the leaves. In a few days the eggs hatch and the young bugs congregate in clusters to feed on the sap, and thus remain until about half grown, when they scatter about over the plant. The adults pass the winter under boards, leaves, rubbish, or anything that affords protection.

This is a common vine pest in certain sections of the State and often causes serious loss to growers of squashes, mellons, cucumbers, etc.

For preventives, remedies, etc , see Nos. 171, 181, 218, 229.

1 Diabrotica 12-punctata, Oliv.
2 Crepidodera cucumeris, Harr.
3. Anasa tristis.
*Compiled.

138. *The Melon Plant Louse*,[1]—A greenish black, soft bodied insect, infesting the under surface of the leaves of cucumbers, melons etc., sucking the sap from them; causing the infested leaves and vines to have a dirty, sickly appearance. This plant louse, in general habits and life history, resembles other plant lice, see No. 56.

For preventives, remedies, etc., see Nos. 170, 215*c*, 212, 212*b*, 216, 245, 242, 243.

139. *The False Cinch Bug*.[2]—Adult a grayish brown stink bug resembling the chinch bug somewhat, in form and habits, but does not show the contrasting black and white colors of the latter. It infests the tender leaves and the terminal shoots of the vine, checking its growth and causing a diseased condition.

The young are louselike, wingless creatures, resembling somewhat the adults

This was an exceedingly common insect on musk-melon vines in market gardens near Morgantown during the summer of 1895, where it did serious damage. It also attacks other plants.

For preventives, remedies, etc., see No. 171, 209, 212*b*

The Fruit.

Holes bored into the green fruit by worms. See No. 140, 141.

140. *The Pickle Worm*.[3]—A yellowish white worm, about an inch long when full grown, with transverse rows of shining spots on each segment; boring into the young fruits and rendering them worthless. A yellowish brown moth; the front wings with dull, golden yellow markings, and the inner two thirds of the hind wings of the same color.

The eggs are deposited by the moth in June or July. The worms begin to appear about the middle of July in this latitude, and continue their destructive work until September. They bore holes into the fruit and feed upon the fleshy part. Reaching maturity in three or four weeks, they forsake the fruit, and draw together a portion of the leaf that is near or on the ground and there in make their cocoons of white silk. Here they soon change to a brown chrysalis and if not too late in the season, emerge as a moth in about ten days. If late, they remain in their cocoons until spring.

This insect is widely distributed over the country, but has not been observed by us or reported in West Virginia.

For remedies, preventives, etc., see No. 232.

141. *The Melon Worm*[4]—A yellowish green worm, attacking both the young melons and the leaves, changing to a beautiful moth with glistening white wings, bordered with black.

This insect has not been observed by us in this state, but it is said to be quite a serious pest further South.

For preventions, remedies, etc, see No. 232.

1. Aphis cucumberis, Forb.
2. Nysius destructor, Riley.
3. Eudioptis nitidalis, Cramer. 4. Eudioptis hyalinata, L.

TOMATO AND EGG PLANT.

The Stalk.

Plants cut off near the surface of the ground, or suddenly wilt.
If the plant is cut off, see No. 146.
If the plant suddenly wilts, a hole is bored in the stalk, and a brown and white striped worm is found mining in the heart of the stem, see No. 142.

Injury by the Young of Moths.

142. *The Stalk Borer*—(see No. 73). This worm often attacks the stalks of tomatoes.

146. *Cut Worms*—(see No. 7). These insects are often serious enemies of tomato plants.

The Leaves.

Plants defoliated; leaves partly consumed; leaves punctured by small holes or the surface eaten.
If the entire leaf, leaf stalk and a part of the tender branches are consumed, see No. 147.
If leaves are cut off at night, see No. 148.
If plants are defoliated or the foliage presents a ragged appearance, see No. 149.
If small light colored spots occur on the surface of the leaves, or numerous small holes are eaten into them, see No. 150.

Injury by the Young of Moths.

Leaves and leaf stalks eaten or leaves cut off by worms.

147. *The Horn Worm.* See No. 100. This insect is often a serious enemy of tomato plants.
For preventives, remedies, etc., see No. 228; 248.

148. *The Climbing Cutworms.* (See No. 7.) Cutworms often climb the plant at night and feed upon the leaf stalks and tender shoots; cutting the leaves off, which are found on the ground in the morning.

Injury by Beetles.

Plants defoliated; the leaves present a ragged appearance; punctured with small holes or the surface eaten.

149. *The Blister Beetles.*—(See No. 97.) These insects are often destructive to tomatoes and egg-plants.
150. *Flea Beetle.*—(see No. 168.) A small brown and black

species, one-sixteenth of an inch long, is very injurious to young and old tomato and egg plants, eating the surface of the leaf or puncturing it with numerous holes, causing it to have a whitish, sickly appearance.

They have been common and quite troublesome pests in the Experiment Station gardens for the last few years.

For preventives, remedies, etc., see No. 203, 204, 207, 212, 212*b*.

The Fruit.

Holes bored into the green fruit resulting in decay.

151. *The Corn Ear Worm.*— (See No. 80.) This worm also bores into the green fruit of tomatoes and is sometimes a serious pest.

Preventives, remedies, etc., see No. 232.

BEANS.

The Seed in the Ground.

If planted seed fails to germinate and it is not the fault of poor seed, it may be due to injury by ants No. 152, grub worms No. 1, wire worms No. 2, fungus gnats No. 88, etc., although very little observation has been made to determine the extent of the damage caused by those insects.

Injury by Ants.

152. *Ants.*—These insects have been observed feeding upon lima beans just before and after they germinate. The inner portion including the germ was hollowed out and the mealy portion scattered over the ground near the infested seed.

Remedy No. 196.

The Stalk and Leaves.

Plants cut off, or wither and die; stalk or vine and leaves covered with lice; leaves eaten.

If plants are cut off at night, see No 153.

If plant or vine withers and suddenly dies, see Nos. 154–155.

If plants have a dirty and sickly appearance, see No. 156.

Injury by the Young of Moths.

Plants cut off; stalks mined; or leaves cut off by worms.

153. *Cutworms*, (See No. 7.)—These insects often do serious damage to young bean plants by cutting them off, and some damage to old plants by severing the leaves and tender shoots.

173. *Stalk Borer.*—(See No. 73.)

155. *The Bean Vine Borer.*[1]—A new pest resembling the squash borer; observed in Wood county in July, 1893, where considerable damage was done. My attention was called to it by Mrs. Bradford Neal. It is a whitish worm about one inch long, resembling very closely the Squash Borer, No. 129. Attacking pole lima bean vines usually at a point two or three feet above the ground. Remedy No. 230.

Injury by Plant Lice.

Plants of a dirty, sickly appearance and covered with lice.

156. *The Bean Plant Louse.*[2]—Similar in appearance and habits to other plant lice. See Nos. 56, 138.

The Green Pods.

Holes bored into the green pods and the contents consumed.

157. *The Corn Ear Worm.*—(See No. 80.)—This insect did considerable damage in Monongalia county to green beans and peas in the spring of 1895, attacking the pods of bunch, corn or pole and lima beans, rendering them worthless for use.

Injury by a Beetle and Its Young.

If beans are found to have numerous holes in them and the inner substance converted into a powder, see No. 158.

158. *The Bean Weevil.*[3]—A small, brownish beetle about one-eighth of an inch long, with wing covers shorter than the body; the young, a small, whitish, footless grub, infests the bean, destroying the germ and rendering it worthless for seed.

The eggs are deposited by the female beetle on the pods of the growing beans, and the young grubs hatching from them mine into the growing seed within, where they remain, feeding but little during the summer, but in the fall and winter they consume the inner substance and soon change to the pupa and then to the beetle which bores out through the skin, often leaving it full of holes. The beetles may also deposit eggs upon stored beans and the young enter the dry seeds and produce in this manner several generations.

From one to fifteen grubs may occur in a single bean.

This is an extremely common pest in West Virginia, and doubtless occurs in all parts of the State, since we have received it from many widely separated sections

See preventives, remedies, etc., see Nos. 213, 214, 216.

1. Sesiid sp?
2. Aphis sp.
3. Bruchus obsoletus, say.

Peas.

The same insects that attack the bean may attack the pea, except the weevil attacking the stored peas.

159. *The Pea Weevil.*[1]—A small, brownish beetle, three eighths to one-fourth of an inch long, marked with a few white spots on the wing covers; otherwise resembling the bean weevil; the young is also similar in appearance and habits to that of the bean weevil, except that but one grub occupies a single pea and the germ is not disturbed; since buggy peas will, as a rule, grow when planted, but will not make as vigorous, healthy plants as will those that are not infested. The pea weevil also differs from the bean weevil in not developing a second brood in the stored peas.

Remedies, preventives, etc., see No. 213, 214, 216.

CELERY.

PARSNIPS, PARSLEY, CARAWAY, ETC.

The Leaves.

Leaves partly or wholly consumed, wilt, appear sickly, or full of small holes.

If leaves are eaten and balls of excrement are found under the plant, or the leaves have a ragged appearance, see Nos. 160, 161.

If the outer leaves wilt and droop, and small black bugs occur at the base of the leaflets, see No. 162.

If the leaves have a dirty, sickly appearance and are covered with plant lice, see No 163.

Injury by the Young of a Butterfly and a Moth.

Leaves of a ragged appearance infested with worms.

160. *The Celery Caterpillar.*[2]—A larva with transverse marking of yellow and black, about 1½ inches long; when disturbed they thrust out a pair of organs or horns just back of their heads that emit an offensive odor. Infest the leaves of celery, parsnips, etc,, change to a black, swallow tailed butterfly marked with yellow.

The butterfly deposits her eggs on the under side of the leaves. The larvæ hatching from these eggs feed on the leaves till full grown, when they leave the plant, and in some secluded place change to a chrysalis and in about ten days or two weeks the perfect insect appears.

This is a common pest in West Virginia, but seldom seriously injurious.

For preventives, remedies, etc., see No. 228.

1 Bruchus pisi Linn.
2. Papilio asterias, Fabr.

161. *The Zebra Caterpillar.*—(See No. 123). This insect attacks the celery as well as cabbage.

Injury by Bugs and Plant Lice.

The extremity of the leaf and the first two leaflets drooping and wilted; later second pair of leaflets affected and at the base of the stem cluster of small black bugs occur.*

162. *Negro Bug.*[1]—Adult a small, black insect, about one-eighth of an inch long by one-twelfth broad; feeding in clusters at the junction of the leaflets with the main stalk. The young similar to the adult.

A common insect in West Virginia on weeds or other plants and is the insect usually to blame for the disagreeable buggy taste of berries.

This insect has been seriously injurious to celery in Michigan and other sections.

163. *The Celery Plant Louse.*[2]—Similar in general appearance, habits and life history to the cabbage and other plant lice. See No. 125.

TOBACCO.

The Roots.

The young plant fails to grow, wilt and die.

Injury by the Young of Beetles.

The roots or the base of the stalk eaten, or the main root mined.

164. *White Grubs.*—See No. 1.

165. *Wire Worms.*—See No. 2.

The Stalk.

Stalks cut off near the ground.

166. *Cutworms.*—(See No. 7.) These insects sometimes do serious damage to young tobacco plants.

1. Corimelæna pulicaria, Germ.
2. Ropalosipum dianthi, Scho. * Compiled.

The Leaves.

Portions of the leaves consumed, also filled with holes or the surface eaten in spots.

If leaves are partly or wholly consumed and large balls of excrements occur under the plants. see No. 167.

If holes are eaten into the leaves, see No. 168.

Injury by the Young of a Moth.

Portions of the leaves consumed by large green worms.

167. *The Tobacco Worm, or Horn Worm.*[1]—A large, green worm about three inches long when full grown, with a horn on its tail and oblique stripes on its sides. This worm changes to a large moth common among Jamestown or Jimson weed blossoms.

The eggs are laid in the spring and the larvae hatching therefrom feed until about the last of August when they have reached full growth. At this time they burrow into the soil and soon change to brown pupae with a jug like handle appendage. In this stage they remain until spring when the moths emerge.

This, and nearly related species, are common insects in West Virginia, the worms also infesting tomato and other similar plants.

Remedy, etc., see No. 228–248.

Injury by Beetles.

Small holes eaten in the surface or through the leaves.

168. *Flea Beetle.*[2]—Small, brownish beetles infesting the leaves and jumping like fleas when disturbed.

This is a common tobacco pest and quite often causes serious damage to the leaves. It causes, however, what is known as spotted wrapper tobacco, which is considered ornamental for cigars, and is in demand on this account. This condition is caused when spots are eaten in the surface and do not extend through the leaf. The damage, however, to the tobacco by this insect doubtless exceeds any benefit that may be derived from the mottled condition.

For preventives, remedies, etc., see No. 212.

Dry Leaves and Manufactured Products.

Dry leaves eaten full of holes and tobacco dust scattered about, through or beneath them where they are stored; cigars and cigarettes with small holes in them.

1 Phlegethontius Carolina.
2 Epitrix parvula, Fab.

Injury by the Beetles and Their Young.

Character of injury as above.

169. *The Cigarette Beetle.*[1]—A small, brown beetle three-sixteenths of an inch long, feeding on tobacco, cayenne pepper and medicinal roots; often causing serious damage to stored and manufactured tobacco.

This insect is common in Morgantown and doubtless in other sections of the State. There are also other species of beetles nearly related to the Cigarette Beetle that feed upon dried tobacco.

For preventives, remedies, etc., see No. 232.

ONIONS.

The Roots or Bulbs.

Leaves wilted, lying prostrate on the ground and perhaps turned yellow.

Injury by the Young of a Fly.

The base of the young plant or the bulb mined by a maggot.

169*a*. *The Onion Maggot.*[2]—A white maggot, about one-third of an inch long, tapering to a point from the hind end which is thick and blunt, with small, tooth-like projections. It changes to a fly similar to a cabbage maggot fly to which it is nearly related and has a similar life history.* See No. 111.

This is a widely distributed insect, and although we have not seen it in West Virginia, it doubtless occurs in some localities.

For preventives, remedies, etc., see No. 197*f*, 213, 216.

169*b*. *Cut Worms.* (No. 7) are also serious enemies of the onion.

METHODS OF COMBATTING INSECT PESTS.

Preventives.

Preventives and precautionary methods of dealing with insect pests are of prime importance, and every one who suffers losses in any way from the presence of insects on cultivated plants, should study this phase of the subject thoroughly, and thus endeavor to avoid the necessity of the proverbial pound of cure.

1. Lasioderma serricorne, Fab.
2. Phorbia (anthomyia) ceparum, Meig. *Compiled.

High Culture and Clean Farming.

In dealing with the insects of the farm there is nothing, perhaps, that will contribute so much, generally speaking, to exemption from serious insect depredations as will high culture and clean farming.

170. *Healthy Plants.*—It is a well known fact that vigorous, healthy growing plants are far less liable to attack, and are far more likely to recover from injury, than those that are in any way weakened in vitality from lack of fertility or neglect. Therefore, if the farmer and gardener gives special attention to the fertility and drainage of his land, procures the best seed and by proper planting and cultivation secures vigorous plants from the start, and by proper care endeavors to keep them in this condition until the product is matured, he will have accomplished more in preventing loss from insect depredations than he would accomplish by the best remedies known applied to half-starved, neglected plants.

Healthy, vigorous plants will seldom be attacked or seriously injured by Plant Lice, such as the Corn Root Louse, Grass Root Louse, Wheat Midge, Cabbage Louse, White Grub, Wire-worm, Stalk Borer, &c.

Weak plants are a menace to healthy ones, since they are attacked by *plant lice* and other insects, and thus form a nucleus from which invasions may start that will result in the destruction of the healthy plants, except when the natural enemies of the injurious insects are common when such plants may exert a beneficial influence. See No. 246.

171. *Clean farming and gardening* is also of especial importance in preventing the multiplication of pests, by depriving them of breeding and hiding places. Especially is this so with reference to those insect enemies of cultivated plants which breed in weeds of various kinds, and those that pass the winter in dead stalks, stubble, weeds, etc. Clean farms and gardens will offer unfavorable conditions for *Cut-worms*, *Stalk Borers*, *Chinch Bug*, *Harlequin Cabbage Bug*, *Cabbage Maggots*, *Joint Worms*, the *Hessian Fly*, and all other insects that breed in the stalks of small grain or pass the winter in the old stalks and stubble. Among the most important methods in this line are the following:

172. *Destruction by fire*, *feeding to hogs* or other stock all infected plants or fruit, surplus vegetables, rubbish and waste materials.

173. *Destruction by Fire, or otherwise*, of the stubble, stalks and straw of crops that have been badly infested by insect pests, provided the parasites of the insects are not common. See No. 246.

These methods are important to prevent and destroy *Cut-worms*, *Cabbage Maggots*, the *Chinch Bug*, the *Harlequin Cabbage Bug*, the *Potato Stalk Borer* and insects that infest the stalks of wheat.

174. *The Destruction of growing weeds* to prevent the breeding of the common *Stalk Borer*, *Clover Stem Borer*, etc.

Fertilization.

Under this head much can be accomplished in the prevention of loss from insect ravages, both in the securing of vigorous plants and in the influence of the fertilizer material upon the insects.

175. *Stable, barnyard and vegetable home made manures* are of advantage in preventing loss from some insects, yet they may contribute to favorable conditions for the increase of others. Stable manure applied to sod land and plowed under for corn has been found advantageous on land badly infested with *white grubs* and *wire worms*. On the other hand stable manures applied in corn and potato hills or drills may result in serious damage from the *black headed grass maggots*, *potato scab gnat*, and other injurious insects that are attracted by the manure.

176. *Kainit* and other *potash fertilizers*, as well as those containing a large per cent of phosphoric acid and nitrogen have been recommended by entomologists and others as valuable preventives and remedies against insect attack.

Ashes may also be used to advantage both as an insecticide and a fertilizer, dusted on the leaves of plants and placed around the root.

177. *Tobacco, dust and stems*, is a valuable insecticide, and these waste products are worth all and more than they cost as a fertilizer, when dusted on the leaves and placed around the plants.

General Farm and Garden Management.

In efforts to control and prevent insect depredations much depends upon general management. Neglect and bad management will contribute to the rapid multiplication of insect pests and to the losses from their depredations, while the opposite will contribute to the diminution of the pests and to the advancement of the profits on the products.

178. *Rotation of Crops.*—Annual plants should be grown in the soil as far removed from that in which they were grown the previous year as possible, and the same class of plants should not be grown in the same land oftener than every other year, or if possible, not oftener than every three years. Perennial plants, such as grass, clover, etc., should not occupy the soil after they cease to yield a profitable return. When they begin to fail from

injury to the roots by insects or from other causes much benefit will result from planting the lands to cultivated crops one or two years, followed by small grain before seeding to grass again.

Rotation of crops offers unfavorable conditions for *grub worms*, *wire worms*, *northern corn root worm*, *corn and grass root aphids*, *corn ear worm*, *wheat straw worm*, *Hessian Fly*, and other insects infesting growing wheat, cabbage, onion and corn.

Time of Plowing.

180. *Summer Plowing* —When it is desired to reseed meadows and pastures without planting to any other crop, the land should be plowed in June or July, and again in August, then seeded to mixed grasses. This will destroy many insects and prevent *cut-worm moths*, the adults of *wire worms*, *grub worms* and other destructive insects from depositing eggs. Meadow lands plowed and reseeded in this manner every three years have been found to yield bountiful crops and to be reasonably free from insect attack.

181. *Fall Plowing.*—To destroy young cut-worms and prevent the moth from depositing eggs in land intended for spring crops, also to destroy or drive out other insects such as the *white grub* and *wire worm pupae*, *army worm*, *corn ear worm*, *harlequin cabbage bug* *chinch bug*, etc.

182. *Winter Plowing.*—To destroy pupae of *grub worms*, *wire worms* and other insects as above.

183. *Deep Plowing.*—To destroy the *wheat saw fly*, *wheat midge*, etc.

Time and Method of Planting.

184. *Early Planting of Wheat* and early varieties to prevent the attack of the *Wheat Midge*.

185. *Late Planting* of wheat, cucumbers, melons, etc., to prevent the attack of the *Hessian fly* on wheat, *striped cucumber beetle on cucumbers*, and *striped flea beetle* on cabbage.

186. *Growing Plants in Large Quantities.*—This method has been found to prevent serious injury from *cabbage worms*, and doubtless will do the same with many other insects since it gives the parasites and other enemies an opportunity to breed and keep the injurious kinds in check. There are also other advantages in growing large quantities of certain vegetables and plants which makes this an important one to consider.

Harvesting.

187. *Early harvesting* to destroy the *clover seed midge* and prevent its attack on the second crop.

188. *Early threshing* to prevent the attack on wheat grain by the *Angumois grain moth, wolf moth*, etc., and to destroy the *wheat stem maggot.*

189. *Pasturing stock* on early sown wheat in the spring to destroy the *Hessian fly.* Late pasturing clover to prevent the attack and destroy the *clover seed midge.*

190. *Removal of infested products*, as far as possible from the growing crops or stored products that are liable to be infested. This refers to the removal of harvested small grain infested by any of the straw inhabiting insects, as well as grain infested with *grain moths* and *weevils;* also clover hay infested with the *clover hay worm.*

191. *Clean Mows and Granaries.* Removal from barn mows and stacks of all old hay infested with the *clover hay worm*, and small grain infested with *grain weevils*, before the fresh product is stored. All grain should be removed from granaries and if pests are present, thoroughly fumigate with bysulphide of carbon before new grain is stored in them.

192. *Feeding surplus infested and refuse products to stock.*—All surplus and refuse vegetable pro ucts infested by insects or those that are liable to become so, should be fed to hogs or other stock ; and all clover hay should be fed or otherwise disposed of before the new crop is harvested.

193. *Starving Out.*—If a given plant or set of plants are so badly infested with insects that it is no longer profitable to grow them, a general abandonment of their growth for a few years will serve to starve out the insects. Cultivation of infested soil during the summer to keep down all vegetation will starve out many insects and prevent others from depositing eggs.

194. *Exempted Localities.*—It is sometimes found that from elevation, soil, and climatic conditions or from other unknown causes, some localities are totally exempt from certain insect pests. This in the case of the rose bug, fungus gnats, wire worms, grasshoppers, blister beetles, a id many other insects is due largely to soil conditions. This is an important subject regarding which comparatively little is known. Hence, the importance of our readers making a study of it and of our correspondents notifying us of the occurrence or non-occurrence of the different pests in their respective localities.

195. *Drainage* is a preventive against wire worms, meadow maggots, black-headed grass maggots, fungus gnats and scab gnats.

196. *Destruction* of *ants' nests* is a preventive against corn root lice and other plant lice fostered by ants. Nests or colonies of

ants may be easily destroyed with bi-sulphide of carbon, or boiling hot water poured into a hole made with a stick or a piece of round sharpened iron bar. Their nests may be located by following their line of march to and from their feeding ground. (See also poisoned bait, No. 41.)

Repellents.

197. *a. Kerosene; b. turpentine; c. coal tar; d. carbolic acid* and like substances are sometimes used in connection with sand, sawdust and like material plac d around or near plants to repel insects by the strong odor.

197*e.* *Naphthaline*, placed with stored grain, beans, etc., will tend to prevent the attack of weevils.

197*f.* *Paraffine Oil* is also used to destroy and prevent the attack of the onion maggot.

197*g.* *Tansy Tea* is sometimes used on cabbage to prevent the attack or drive away cabbage worms as well as the butterfly that deposits the eggs.

197*h.* *Salt.*—A small quantity pla ed around young plants of various kinds is said to be a successful remedy against *cutworms*, the *corn web worm* and *white grubs.*

Fencing Out.

198. *Thin cheese cloth, muslin and wire netting* placed over cucumber and other plants to keep out insect pests until the plants have become sufficiently strong to resist the attack. *Striped cucumber beetles, striped flea beetles* on cabbage, *blister beetles* and many other insects may be fenced out in this manner.

199. *Paper and metal bands* placed around the stalks of young plants will prevent the attack of *cutworms.* This is also a successful method of preventing the attack of other insects having similar habits.

200. Boards coated with coal tar to fence out chinch bugs, traveling cut worms, etc. Is said to be a successful fencing out method.

201. *Coal tar* and like substances poured on the ground around plats and fields against *chinch bugs, traveling cutworms, army worms, &c.*

REMEDIES.

Ansenites.

203. *Paris Green* (poison).—A well known and common remedy for almost all kinds of insects that bite and consume the leaves

of plants. There are two kinds of this insecticide, one *aceto-arsenite of copper*, which is the common green substance; the other, *arsenite of copper*, a much finer substance and of a lighter tint*. Both are used in the powder and liquid form as follows: For a spray use one pound of the poison to 150 to 200 gallons of water. When used dry it is mixed with flour, road dust, plaster or coal ashes. To 10 lbs. of flour or 20 lbs. of any of the other substances, add 1 lb. of the poison and mix. This is dusted on the plants by placing a quantity of it in a muslin bag which is attached to the end of a stick and the dust distributed by striking the bag with another stick. It is also applied with powder bellows and powder gun. The liquid is applied with a wisp sprinkler or some form of force pump. See Bulletin 21 and 43 of this station for description of apparatus for applying insecticides.

204. *London Purple (Poison).*—Similar to Paris Green and is used in the same manner.—It is cheaper but more liable to injure the foliage.

205. *White Arsenic (Poison)* is sometimes recommended as an insecticide, but since it injures foliage worse, and is more dangerous to handle, it is seldom used.

206. *Arsenite of Lead, (Poison),*† a new insecticide, a combination of arsenite of soda and acetate of lead, mixed as follows:

11 ounces acetate of lead
4 ounces arsenate of soda
100 gallons of water
2 quarts glucose or molasses.

The same proportions as above may be used for smaller quantities. It is applied in the usual way. It does not injure the foliage.

207. *Arsenates and Copper Sulphate, (Poison.)*—A combined insecticide and fungicide—Paris Green, London Purple, etc.,—mixed with blue vitriol and lime, as follows:

Dissolve 6 lbs. copper sulphate (blue vitriol) in a wooden or earthen vessel; in another vessel add to 4 lbs. of fresh lime enough water to reduce it to the consistency of a thick whitewash. Pour this slowly into the copper sulphate solution, strained through a coarse sack stretched across the top of the vessel. Dilute to 45 gallons before using, and add 2 ounces Paris Green or London Purple.

208. *Corrosive Sublimate (Poison.)*—At the rate of $2\frac{3}{4}$ ounces of corrosive sublimate to 15 gallons of water is used to soak potato and other seed before planting as a preventive against the attack of insects and diseases of plants.

Contact Remedies.

The remedies that kill by coming in contact with the body and

*Mentioned first by the Division of Entomology, U. S. Dept. Agr. through Mr. C. L. Marlatt in Insect Life, Vol VII., pp. 408-411.
† Introduced by the Gipsy Moth Com. of Massachusetts.

breathing pores are used against insects, which, owing to their feeding habits, cannot be killed with poisons, such as true bugs and plant lice that feed upon the juices of plants by sucking it out; also grain and seed infesting insects in granaries, etc., which can be reached only with deadly gasses.

209. *Kerosene Emulsion* is one of the best contact remedies known for the destruction of plant bugs and plant lice. It is prepared and applied as follows: In 1 gallon of boiling water dissolve, thoroughly, ½ lb. hard, soft, or whale oil soap; while this is very hot add 2 gals. of kerosene, and at once commence to churn the whole mass with a syringe or force pump, drawing the solution into the syringe or pump and forcing it back into the vessel. Continue this until the whole mass assumes a creamy appearance and will adhere to the sides of the dish instead of gliding off like oil. This is the stock or standard emulsion, and must always be diluted before using; to what extent depends upon the class of insects to be treated; usually dilute with about 12 parts of water.

210. *Potash Soap.*—Concentrated lye 1 lb.; cotton seed oil 3 pints.; soft water 3 gals. Boil the lye in water until dissolved, then add the oil and boil two hours, replacing evaporated water with hot water from time to time. Use 1 lb. of this mixture to 8 or 10 gals of water for plant lice or to 1 gallon of water for scale insects, &c.

211. *Whale Oil Soap.*—Concentrated lye 1 lb.; whale oil 3 pints.; soft water 3 qts.; directions same as above.

212. *Pyrethrum Insect Powder.*—A vegetable substance ground into a fine powder, which is, when fresh and pure, a valuable insecticide. It may be diluted as follows:

Pure powder 1 part, wheat flour 10 to 20 parts; allow it to stand in a tight vessel for a few days before using. Apply with powder gun or bellows to cabbage to kill cabbage worms, flea buttes, etc. It may also be used in a liquid form, which is prepared by stirring one table-spoonful in two gallons of boiling water, and use with a sprayer as soon as the liquid is cool enough.

212*a*. *Tobacco* in various forms is a valuable insecticide. It serves as a preventive and repellent, a poison and a contact remedy.

212*b*. *Tobacco Dust* is a cheap waste product valuable to destroy plant lice and prevent the attack of the *striped cucumber beetle*, *flea beetles*, etc.

212*c*. *Tobacco Stems* are valuable to place around plants, serving as a mulch and a repellent against insect attack.

212*d*. *Liquid* made by boiling stems or dust in water to form a strong decoction, which is applied with a sprayer.

213. *Hot Water* at nearly the boiling point or just hot enough to kill the insects and not injure plants, *for cabbage worms, onion maggots, harlequin cabbage bug, ants in nest*, etc., has been recommended.

214. *Heat* is used to kill the young weevil grubs in beans and peas before storing them; dry heat at about 130 to 145 degrees for four or five hours will kill all the young grubs and will not injure the beans for use or planting.

Dust.

215. *a. Lime; b. plaster; c. road dust; e. ashes; f. soot*, are used with some success against *flea beetles* and some other leaf eating insects.

Poisonous Gases.

216. *Bisulphide of Carbon.*—A liquid substance that may be procured at drug stores. It gives off a gas that when confined in a tight vessel, box, bin or room will kill all kinds of insects confined with it. It is of especial value to destroy grain weevils, grain moths, bean and pea weevils, and certain earth inhabiting insects as root lice, ants, and cabbage maggots.

Application.—Bisulphide of carbon is for sale at drug stores at from 20 to 30 cents a pound. "A grade known as fuma bisulphide for sale at 10 cents a pound, is said to be much more effective than the ordinary grade on the market. It is applied at the rate of about one pound to one hundred bushels of grain. If the bin or granary is moderately tight, saturate bits of cotton waste and distribute about on the surface of the grain. The liquid rapidly changes to a gas, which being heavier than air, descends through the mass of grain, killing all insects, mice or rats which it may contain. It adds to the efficiency of the remedy if blankets are spread over the surface of the mass of grain."

To destroy bean and pea weevils, place the seed in a tight vessel and treat with a small quantity of the liquid, as mentioned above.

For insects in the earth, inject the liquid into the soil as near as possible to the insects it is intended to kill.

The gas is injurious to all animal life, including human beings, when confined in a tight room with it. It is also explosive, and a fire should *never be allowed to come in contact with the liquid or the gas.*

Miscellaneous Methods and Remedies.

217. *Trapping.*—This is a method successfully employed against a number of insect pests, the most important of which are as follows:

218. *Trap Crops or Plants.*—Rows or patches of plants are provided to attract insects so that they may be easily destroyed. This method is used against cabbage insects by planting rows of winter turnips, mustard or rad-

ishes in the land intended for cabbage and other related plants. The trap crop is started early and allowed to grow until thoroughly infested with the *harlequin cabbage bug, cabbage worms, cabbage plant lice*, and the *root maggots, flea beetles*, etc., then the plants and insects are destroyed by spraying with pure kerosene oil or boiling hot water.

219. *Trap Crop* for wheat infesting insects, especially those infesting the young plants, a strip of wheat is sown early along one side of the field intended for wheat. Then, just before sowing, plow the trap crop under, or destroy it by cultivation during a hot, dry day.

220. The squash borer, squash bugs and other insects may be trapped and destroyed in a similar manner by starting a few plants early for the especial benefit of the insect.

221. *Trapping Under Boards, Leaves and Bunches of Grass* — Cutworms, the harlequin cabbage bug, the squash bug; etc., may be attracted to bunches of grass, cabbage leaves, boards, etc., laid on the ground near the infested plants, under which the insects will seek shelter, and may be easily collected and destroyed early each morning.

222 *Ditching against army worms, chinch bugs, grasshoppers.* — When these pests are threatening a crop, it may sometimes be protected by a ditch surrounding it, into which the insects fall and may then be burned by the aid of straw scattered in the ditches, or if water can be run into the ditch, a small amount of kerosene or petroleum on the surface will accomplish the desired result.

223. *Hopperdozer.*—A long shallow pan containing coal tar or kerosene, back of which is a screen, pulled by a horse over a badly infested field. This method is extensively used in the west where it is claimed to be one of the best methods of destroying the young of the Rocky Mountain locusts. The insects jump into the pan and are killed by the tar or oil.

224. *Windrows of Straw* placed along the edge of a field into which blister beetles may be drawn and then burned.

Baiting.

225. *Poisoned Bait.*—Clover, grass and any early vegetation cut and tied in small bundles, then dipped into strong Paris green water and scattered over the ground just before the plants are set out is an excellent method for destroying cut-worms. Poisoned wheat bran is also used for this purpose, placed near the plants that are to be protected. Sweetened poisoned baits might also be used to destroy aphid-protecting ants.

226. *Trap Crops* of vegetables and plants also can be utilized for this purpose by spraying them with the poison.

227. *Potatoes cut and stuck on the end* of a stick and placed in the ground where wire worms are common is said to be a good way to trap these insects. When they collect on the potato they are lifted out by means of the stick and destroyed.

Hand Picking.

229. *Adults, eggs and larvae*, collected by hand when they first appear, is often one of the best methods to prevent future trouble, especially when there are only a few plants to protect, and it may frequently pay on a large scale if cheap labor can be had. This method is used against the following insects: *white grubs* collected after the plow, the *corn ear worm*, the *Colorado potato beetle* and its eggs when they first appear, *tobacco* and *tomato worms*, *tortoise beetles* and young on sweet potato vines, first adults of the asparagus beetle, the celery caterpillars and the first cabbage butterflies appearing in the spring, which may be caught with insect nets by children.

230. *Digging Out or Cutting Out.—Cutworms* are dug out from around recently injured plants, and *web worms* and *corn worms* collected in the same manner. *Stalk borers*, *squash* and *bean vine borers* may be cut out without injuring the plant if they are detected soon after they enter the vine.

231. *Jarring and Beating.*—The *Colorado potato beetle* and its young may be collected by beating them off the vines into a pan containing a small quantity of water and kerosene. This is a method that is extensively adopted in kitchen gardens and by persons who object to using poison insecticides.

232. *Destruction of Infested Plants and Fruit* is an important and simple method of destroying many insects, such as the *sculptured corn curculio*, *stalk borers* and the *cabbage maggot*, the *potato stalk borer* during the growing season and after digging the potatoes by burning the infested vines ; the destruction of vines infested with the *squash borer ;* pickles and melons infested with the *pickle worms*, and volunteer wheat to destroy the *Hessian fly* and other insects with similar habits.

NATURAL ENEMIES.

Domestic Animals.

233. *Hogs* are serviceable in rooting out and destroying *white grubs* and other insects in sod land just before plowing for a crop. Many waste surplus and infested vegetables may be profitably fed to hogs and at the same time materially lessens the number of insect pests.

234. *Poultry* destroys immense numbers of insects and may be profitably employed against certain pests such as the *asparagus beetle*, *grasshoppers*, *cutworms* and many other insects.

235. *Turkeys* are especially fond of *grasshoppers*, and a flock of them on a farm, will render valuable service against these pests.

236. *Young chickens* cooped up in the garden will destroy immense numbers of striped cucumber beetles, flea beetles and other smaller insects

237. *Other Live Stock* may sometimes be used to advantage to eat down early sown wheat and thus destroy the Hessian fly and other insects that attack the young stalks of wheat; also to keep down volunteer grain in stubble land and to consume surplus feed, such as clover, etc., to prevent its being kept over.

Wild Animals.

238. Among the wild animals there are numerous insect destroyers.

239. *Skunks* are among the most valuable in destroying white grubs, since they search for and dig great numbers of them out of the ground. They also feed upon other insects.

240. *Toads* are great insect destroyers and may possibly be utilized to an advantage in gardens.

241. *Birds* consume immense numbers of insects, but make no choice between injurious and beneficial ones.

Beneficial Insects.

There are almost if not quite as many beneficial kinds of insects as there are injurious ones, consisting of *predaceous insects*, which attack and devour insect pests; and *parasitic insects*, which breed in the living bodies of other insects, and thus cause their final death.

242. *Predaceous Insects.*—Among the beneficial insects of this class are *lady birds*, *ground beetles*, *bristle flies*, (*tachina flies*,) *soldier bugs*, etc.

243. *Lady Birds or Lady Beetles* are among the best friends of the farmer, destroying, as they do, immense numbers of plant lice and insect eggs. They are small, broad-bodied beetles, usually red or yellow, with black spots on their wing covers. Their young are small, blackish, long, soft-bodied creatures which are also ravenous feeders upon plant lice. When these insects are abundant, in company with plant lice, care should be taken not to destroy them.

244. *Ground Beetles.*—Black, blue and green shining beetles of various sizes, from very small to an inch or more in length, in-

cluding a great many different kinds; found in the ground under stones and boards, running around on the surface of the ground, or climbing plants. Some of this class of predaceous insects, both in their adult and young forms, are great insect destroyers, some of which attack the *white grub, wire worms* and *cutwor s.* Others attack the eggs and young of the *Colorado potato beetle*, the latter being a small, blue-backed beetle with a reddish head and thorax.

245. *Parasitic Insects.*—This class of insects includes many hundreds of forms that are among the farmer's and gardener's best friends. The majority of them are minute, four-winged gnats, while others are small, wasp-like insects with long stings, or two winged flies, resembling the common house fly, but usually larger and the body covered with stiff, spiny hairs.

The principal ones with which the farmer and gardener should be sufficiently familiar to readily recognize and protect, as his best allies in combatting insect pests, may be mentioned as follows:

246. *Parasites of Plant Lice.*—It may be safely said that plant lice would be among the very worst insect enemies of plants were it not for their numerous predaceous and parasitic enemies. Before applying a remedy to destroy the lice, therefore, it should be ascertained whether or not these natural enemies are present, and if so, at least a few infested plants should be left to breed the parasites, and if the parasites are very common, it will, in some cases, be best not to attempt to destroy the lice by artificial means, since by so doing more harm than good may be done.

The presence of plant lice parasites may be known by the inflated brownish appearance of some of the lice clinging to the infested plant. On close examination they will be found to be dead, and many of them with round holes in their backs from which minute, wasp-like parasites have emerged. These parasites often appear in great numbers, and if left alone will often practically exterminate the lice. The wheat crop is often saved from serious injury if not total destruction, nearly every year by the attack of these parasites on the grain aphids.

An experiment conducted by us in the greenhouse at the Experiment Station with one of this class of parasites proved that they can be utilized to great advantage in controlling plant lice in the green house.

247. *Parasites of the Cabbage Worms.*—Bunches of small whitish or yellow silken cocoons are often found attached to cabbage leaves infested with cabbage worms. These should be carefully protected since the insects emerging from them are the cabbage growers best friends. They deposit their eggs in the body of the worm; the eggs hatch into minute maggots which soon become

full grown and emerge through the skin of the worm to make their little cocoons either on the back of the worm or the leaf. A great many worms are thus destroyed and if the cocoons are protected, invaluable service will be rendered by the parasites. There is another parasite that attacks the chrysalis of the cabbage butterfly, as many as fifty or sixty of them developing within a single chrysalis.

248. *Parasites of Caterpillers.*—An enormous number of caterpillars like the tobacco worm and potato worm are destroyed by large two-winged flies, which deposit their whitish shining eggs upon the backs of the worms near the head; the eggs hatch into maggots which enter and develop within the body of their host, and after the worm dies, the maggots change to smooth brown, egg-like forms, from which the flies emerge. There are a great many kinds of these flies, and they not only attack all kinds of soft bodied catterpillars, but also attack the young of the Colorado potato beetle, grasshoppers, etc. Therefore, if catterpillars and other insects that are collected by hand are examined and all full grown ones that have eggs on them are left on the plants to breed the friendly flies. much good will be accomplished towards reducing the number of this class of pests.

Tobacco and other worms are also frequently found covered with small, white cocoons, similar to those of the cabbage worm parasite. All worms thus infested should be left on the plant until the parasite emerges.

Diseases of Insects.

249. Insects are often attacked by diseases which within a very short time will apparently exterminate all the individuals of a species.

250. *Clover Leaf Beetle Disease.*—The most striking example of this is found in the disease that attacks the clover leaf beetle. Early in May the clover will be found covered with small, green worms that threaten to destroy every vestige of this valued plant in an entire county, but almost invariably a disease appears among them before they have done serious damage, and within a day or two scarcely a living worm can be found. The disease comes like a blighting wind, sweeping over the entire infested area, possibly of thousands of square miles. A few escape, however, to lay their eggs for another brood. Were it not for this disease, it would be impossible to grow clover in the regions infested by the clover leaf beetle.

251. *Chinch Bug Disease.*—The chinch bug is at times attacked by a disease which destroys the bugs over large areas, within a short time. This disease is

being utilized by Entomologists and farmers in Kansas, Minnesota and Illinois, to keep the dreaded chinch bug under control. Diseased bugs are distributed over a field infested b healthy bugs, and if the conditions are favorable the healthy bugs take the disease and die. The artificial introduction of the sick bug is not always successful, but sufficient success has been attained in the States mentioned, to demonstrate the possibilities of this method of combatting certain insect pests that are susceptible to this and like diseases:

252. In a Bulletin just received from the Kentucky Experiment Station, Prof. Gorman gives an account of some interesting results with the chinch bug disease transferred to cutworms, showing that these pests can to a certain extent be killed by it.

252*a*. Grasshoppers are also attacked by a similar disease, and those dying with it may often be seen clinging to stalks of grass, weeds, etc.

253. *The White Grub* is attacked by a peculiar fungus disease which in its final stage of development sends out two growths from near the head of the grub which may extend several inches through the soil until the upper ends reach the open air, when the spores are formed to spread the disease to the other grubs.

254. *The Cabbage Worm* and a number of other insect pests are often attacked by diseases, and many of the young forms are thus destroyed.

These diseases are being studied by specialists in several of the experiment stations with a view to utilizing them, by artificial inoculation and transfer from one locality to another, as a means of controlling certain serious pests. Rapid progress is being made in the knowledge of this subject, some encouraging results have already been obtained.

Caution.

Beneficial animals, insects and diseases attack and destroy enormous numbers of injurious insects. Some injurious kinds, like the clover leaf beetle, the army worm and plant lice which, if unmolested by their enemies, are capable of terrible depredations —are thus often kept in complete subjugation. Parasites and diseases may be introduced to check the ravages of certain insect pests, but it will not do, however, to place too much confidence in these friendly elements of the farmer and gardener, or to even hope that they will, under natural conditions or artificial control, accomplish in every case all that is necessary. At best they can only be considered as valuable aids or allies in our warfare against the insect enemies of plants, to be protected, encouraged and utilized as best we can, remembering that in order for an insect enemy of a plant to furnish food for friendly insects, animals, etc., *it must* itself have food. Thus the plant may be destroyed or ruined before our friendly allies appear.

Some Prime Requisites for Success, in Dealing with Insect Pests.

Fertility of the soil; thorough cultivation; healthy, vigorous plants; clean farms and gardens; and rotation of crops are the prime requisites for preventing serious injury to cultivated plants by insect pests.

In combatting injurious insects the prime requisites for success are a general knowledge of the insect enemies and friends of plants; their habits and the character of their attack; the selection of the proper remedy and its prompt and thorough application upon the first appearance of the enemy; also *the protection and encouragement of all friendly animals, insects and diseases that will aid in the future subjugation and control of the pests.*

Among the requisites for success in preventing the spread of new or strange pests is the sending of specimens of the insect or its work to the Experiment State Entomologist for identification, with a request for information upon the best known methods of combatting it.

Instructions for Sending Specimens by Mail.

If possible, specimens of insects or their work, or both, should always accompany letters of inquiry about insects.

Specimens of dead or living insects may be sent by mail in tin or wooden boxes, quills, hollow pieces of wood, or small vials, packed in cotton. The postage on the package will cost one cent for each ounce or fraction thereof. Specimens of insect work may be enclosed in the letter or in a paper wrapper.

Spraying Machine, Etc.

For descriptions and illustrations of spraying pumps and other apparatus for applying insecticides, as well as further information with reference to the preparation and application of insecticides, see bulletins 21 and 43 of this station.

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